ICU NOTES

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الهدف من الحياة طاعة الله والفوز بالجنة والنجاة من النار بنفسك وأهلك ومن استطعت من الناس كافة.

ولهذا لابد من دعاء وعبادة وعمل وصحبة في وسط حياة لن ترحمك، وظروف ومتغيرات تزداد سوء كل يوم والقادم أصعب.

لا تأمن الفتن، واسأل الله السلامة، وتمسك بالصالحين على قلتهم، وتأكد أن معظم الناس ليسوا على الطريق إلا من رحم الله؛ فلا تفتنك الدنيا فتهلك، وكن عابر سبيل مؤثر في مَن حولك وهذا في غاية الصعوبة.

لو قررت تكمل في "البكابورت" لازم تَلزم والديك وتبرهم فهم باب واسع للجنة، وتقاوم طواحين الهواءمن إدارة ومجتمع سيئ جداً وضغوط حياة لا ترحم، ومهما ضاقت بك الدنيا تذكر أنك تشتري الجنة بنفسك ومالك فلا تيأس واعمل حتى آخر عمرك وسد ثغرك وأعد من تحتك ليصلوا إلى أفضل مستوى بأقرب وقت؛ فهو صدقة جارية وعلم ينتفع به وممكن يكون له تأثير ولو بعد حين ولكن تمتع بالذكاء ولا تقابل فرج.

أعد أولادك للجنة وأخبرهم أنه كبد حتى نلقى الله وادع لهم واتق الله من أجلك وأجلهم واجعلهم يخشوشنوا فإن النعمة لا تدوم وثق أن سترهم بيد الله.

ساعد المسلمين خارج وداخل مصر والبشرية والحيوانات ولا تترك باب خير لإلا وتشارك ولو بالقليل.

عليك بكتاب الله؛ حاول تفهمه وتقرأه صح. تعلم التجويد وحاول تحفظ انت وعائلتك، وعليك بالعبادةخصوصاً بين الناس؛ خُلُق وتعامل وطاعة خفية.

بلاش عليك نفسك واهتم دوماً بأمر المسلمين، وتابع أخبارهم رغم قسوتها وادع وتبرع لهم.

لا تسخر من عاصٍ؛ وادع لهدايتهم والثبات وابحث عن طريق لمساعدتهم.

ساعد الكادحين؛ بيزق عربية على مطلع، ست عجوز بتبيع، وابحث عن المتعففين والمكروبين وما أكثرهم؛ قف بجانبهم وساعدهم وتكفلهم مع الحرص لأنه من الفطنة.

لو فضلت في "البكابورت" فقط بدون عمل هتتحول إلى واحد من القوارض والحشرات أكيد ... طب ده صعب على النفس جدا تعرف تعمله؟! حاول أو هاجر وأرض الله واسعة؛ انج من "البكابورت". تروح فين؟! أفريقيا أو غرباً أو شرقاً.

الهدف طاعة الله والجنةوألا تأخذك الدنيا؛ وأن تكون مؤثر، فاعل، نموذج مشرف، جاهز للعودة عندما يكون هناك وطن أو أهلك يحتاجوك مهما كنت مزنوق في خطوة مهمة.

الأوضاع سيئة وبتزداد سوء، نسأل الله الثبات، وأن يستخدمنا، وأن نموت على الطريق حتى لو لم نرَ النتيجة.

ثق بالله أن يوف يغنيك ويحفظك فهو عند حسن ظن عبده، وحاول أن تصل إلى الرضا فهو راحة الدنيا.

Contents

HOW TO PRESENT A CASE

♦ Name ♦ Age ♦ Gender

Medical history → e.g, DM, HTN + Analysis: duration, treatment & complications.

Surgical history → Mention only if of medical importance.

Cause & date of hospital admission

Cause & date of ICU admission + Day

☜ قول القصة في صورة حكيوة لطيفة chronological ... يعني مثلا عيان اتحجز في المستشفى بـ acute abdomen وعمل exploration فطلع perforated DU حطوا omental patch ... في العملية ضغطه وقع واتحط على ليفو فطلعوه الرعاية .

☞ Cause of hospital admission: Acute abdomen, exploration revealed perforated DU for which omental patch was done ... Cause of ICU admission: hemodynamic instability.

✋ Mention the trauma survey in traumatic cases:

- Neurosurgery → if CT brain is free but the patient is unconscious → post-concussion or diffuse axonal injury → consider MRI with diffusion & EEG.
  Any spinal fractures → Neurological assessment & stability of fracture + Solumedrol.
- Cardiothoracic, General surgery, Vascular, Plastic, Orthopedic, ENT & Ophthalmology.

Picture on admission →→→→ **Sequence of events** →→→→ **Picture now**

يعني تمسك كل system في العيان من أول ما دخل وحصل فيه إيه ودلوقتي وضعه إيه وبعدين تدخل ع الـ system اللي بعده .

1) CNS

➢ **GCS**: ★ If fully conscious & ventilated →→ Mention the medications used for sedation.
Target RASS score: 0 or -1 → see later.
★ If DCL: Mention the GCS in details then mention the following items:

➢ **Pupils** & **signs of lateralization**.

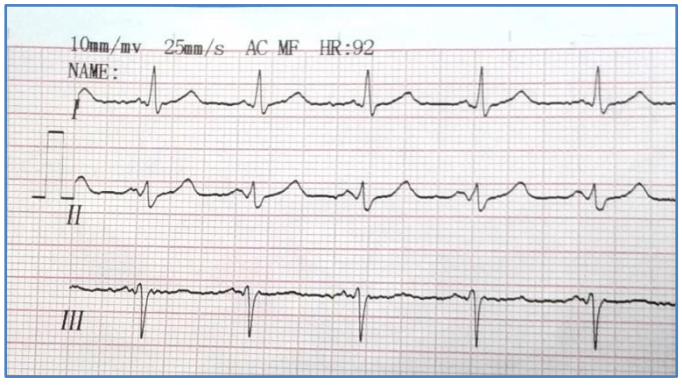
➢ **CT brain.**

➢ **Others:** e.g, EEG &MRI with diffusion in case of convulsions, DCL not explained by CTB or unexplained tachycardia (may be sub-convulsive fits).

2) CVS

➢ **ABP & HR, On inotropes or not** ?? If yes →→ **Mention the DD of shock (page 12)**.

➢ **ECG:**



☜ قبل ما تحكم على رسم القلب لازم تتأكد إنه معمول صح :

1. Voltage: 10 mm/mv (2 large squares)
2. Speed: 25 mm/sec (sec = 5 large sq.)
3. aVR → inverted waves.
4. Compare with previous one to detect dynamic changes.
5. Topography.
6. Assess: Rate, Rhythm & Waves.

Topography: ♦ Septal → V1,V2 ♦ Anterior → V3,V4 ♦ Lateral → V5, V6, I, aVL
♦ Antero-septal → V1,V,V3,V4 ♦ Antero-lateral → V3,V4, V5,V6, I, aVL
♦ Inferior → II, III, aVF.

➢ **Echo:** Left ventricle contractility (EF), Right ventricle dimensions (dilated or not), Fluid status & Pericardium (there is effusion or not).

± **Cardiac enzymes**: Only in shocked cases.

3) CHEST

➢ **Auscultation.**

➢ **Imaging:** CXR→ CVL, lung borders, copula, gastric bubbles, ryle
CT → ETT position, mucus plug, ryle, chest tube.
Lung ultrasound.

➢ **On room air or oxygen therapy.**
If on oxygen therapy →→ Venturi mask or Nasal cannula (flow ?).
If ventilated →→ Ventilation parameters ??

➢ **ABG.**

±➢ **ABG after re-adjustment of ventilator parameters.**

➢ **Differential diagnosis of hypoxia.**

Chest x-ray

1. **CVL:** Site & position + بتتأكد منها إن الصورة دي بتاعة العيان ده
2. **Lung borders:** Pneumothorax. copula cupola.
3. **Copula:** Flat.
4. **Gastric air bubbles:** If distended → ryle malfunction (obstructed or not in place).
5. **Trachea:** Central.
6. **Routine:** Cardiothoracic ratio, pneumonic patches & costophrenic angles.

Differential diagnosis of hypoxia

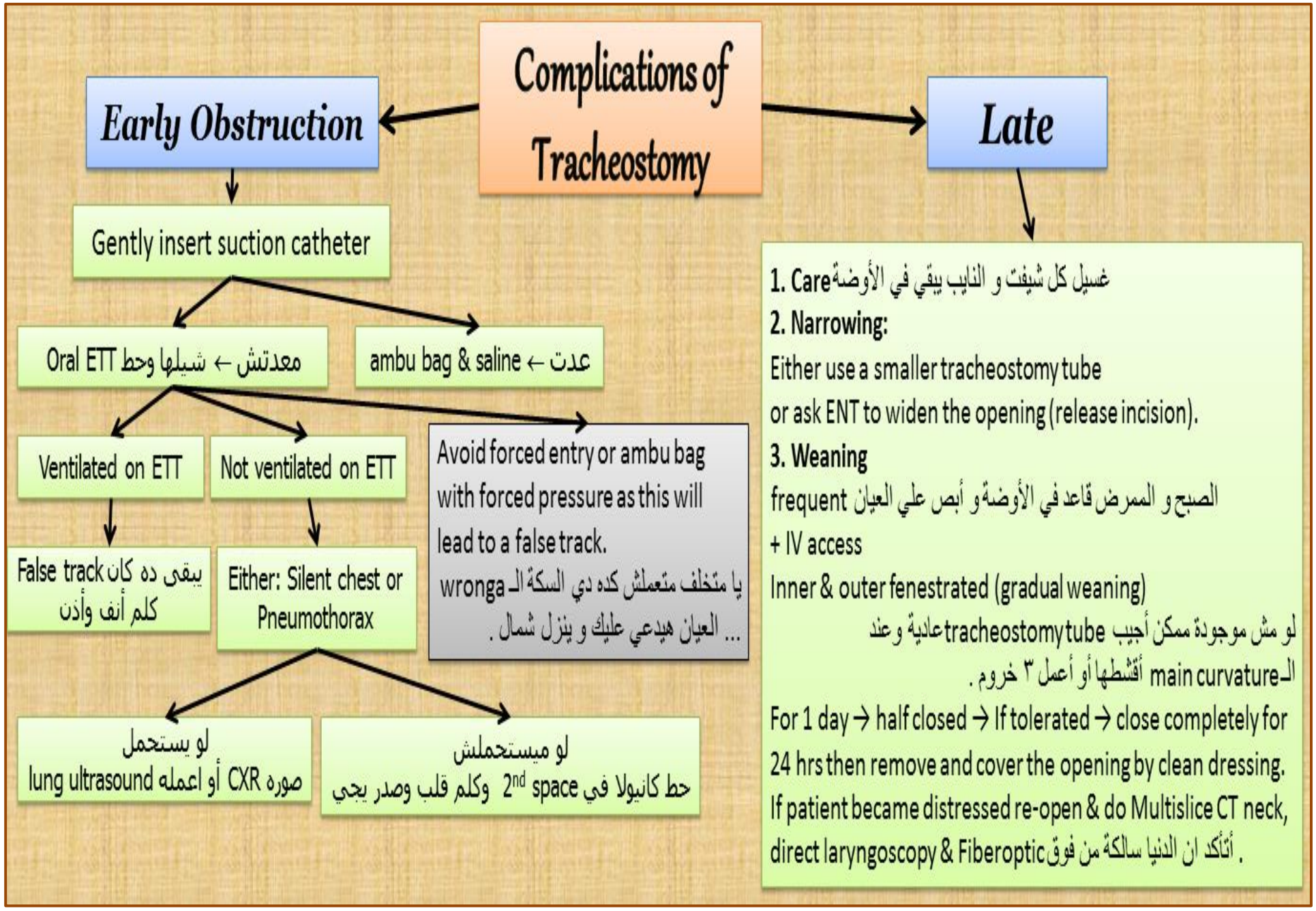
1. **Chest auscultation:**
   - ★ Diminished unilateral: collapse - endobronchial tube - دم - ميه - هواء
   - ★ Diminished bilateral: pleural effusion → treated by PEEP + lasix + cause.
2. **Imaging:**
   - ♦ CXR or CT chest → pneumonia, pneumothorax, ARDS, endobronchial tube ± Lung ultrasound.
   - ♦ Lung ultrasound → pneumothorax .
3. **Echo:**
   - ♦ Right side: Dilated in case of pulmonary embolism.
   - ♦ Left side: Poor contractility is suggestive of heart failure & pulmonary edema.
4. **Numerics of ventilator:**
   - ♦ Check the peak airway pressure, plateau pressure & the tidal volume.
     - ↑ peak & plateau → ↓↓ compliance.
     - ↑ peak & normal plateau → obstruction.

➢ Pleural effusion → chest tube ركب → ساعات 6 واقفلها سم 500 سيبها تنزل → to avoid negative pressure pulmonary edema + diuretics + Lasix

➢ Any hemothorax is an indication for chest tube as it doesn't resolve with diuretics.

Care of tracheostomy

1. Humidifier
2. لو في secretions يتعمل جدول تشفيط واضح .
3. كل ساعتين الـ cuff تتفضى ربع ساعة .
4. بعد أول أسبوع تتشال وتتنظف مرتين في اليوم لأنها بتكون خلاص عملت تراك .
5. لو العيان مش بيتفنتل كويس وكان عدى عليها اكتر من أسبوع شيلها ونظف وشفط ولو لأ شفط بس ...
   لو لسه مبياخدش حط أنبوبة oral وصوره لأن ممكن يكون في pneumothorax .



4) **GIT**

- **Oral or ryle? If ryle mention why?**
- Start oral feeding as soon as possible unless contraindicated (resection anastomosis).
  If small bowel → wait 3 days, if large bowel → wait 5 days, If Perforated DU → wait 7 days.
  متعتمدش على إنك تسمع intestinal sounds عشان تبدأ للعيان enteral feeding لأن 50% من العيانين اللي مش مسموعلهم intestinal sounds بيكون عندهم normal intestinal peristalsis ...
- **Care of wound if present:** e.g, Colostomy →→ viability(color), retraction (if retracted may lead to peritonitis) & output.
- **Care of drainage** →→ output.
- **Others:** ♦ Any ventilated patient →→ Ryle insertion for drainage & feeding.
  ♦ No oral ryle in non-intubated patient →→ high risk for regurgitation & aspiration.
  لو في abdominal incision هتطلب من أهل العيان 4 أحزمة بطن (Abdominal binders) ... حزام لجرح البطن وحزام للـ stoma فيه فتحة ليها ... وحزامين احتياطي عشان لو الموجودين احتاجوا يتغسلوا .

5) **LOWER LIMBS & BACK** →→ Look for edema & bed sores.

6) **LABS.**

7) **BALANCE** → Follow up the trend over every 6 hours & the cumulative balance in last days.

8) **FEVER, TLC, CRP, CULTURES & PROCALCITONIN.**

9) **CHRONIC DEVICES CARE:**

Such as tracheostomy tube, chest tube, urinary catheter, CVL & surgical drain.

Care in the form of → Duration, signs of infection, disinfection, working or not? needed or not?

- ☞ CVL position: 2nd rib anteriorly.
- ☞ Maximum duration for urinary catheters: Foley: 3 weeks … Silicone: 1.5 - 3 months.
- ☞ Maximum duration for CVL: 2 weeks … 10 days in patients with liver or renal transplantation.

10) **TREATMENT** →→ قاعد ليه وبنعمله إيه؟

1. ABC:

يعني العيان يكون ماسك ضغط و saturation خلال نص ساعة

* AB → Ventilatory management + DD of hypoxia.
* C → DD of Shock + management of cause (with relevance to hypoxia).

2. Specific treatment: Refer to protocol.

3. The 4 Anti:

♦ Antibiotics →→ according to protocol.

♦ Anticoagulant: Start as soon as possible unless contraindicated:

→ Active bleeding from the wound or any body orifice.
→ Intracranial hemorrhage or brain contusion→ start on day 4.
→ Suspected bleeding by surgeons.
→ Platelets < 50,000.
Alternative: Intermittent leg compression

- ☞ Start with Clexane 40 mg SC once daily.
- ☞ In case of renal impairment: Heparin 5000 U SC every 12 or 8 hours.
- ☞ In case of thrombocytopenia: Switch to Arixtra or Thrombex.
- ☞ Suspect HIT after day 4 or earlier with history of previous exposure to heparin.

Thrombocytopenia

Hemolytic Uremic Syndrome (HUS)	**Thrombotic Thrombocytopenic Purpura (TTP)**
Neurological manifestations Renal Thrombocytopenia	Hypercoagulable state (DVT, Stroke) Thrombocytopenia
DD: LDH, Blood film (schizocytes) & Coomb's test.	

Anticoagulants

	When to stop **before** regional	When to start **after** regional
Clexane	12 hours	2 hours
Heparin	4 hours	1 hour
Arixtra	36 hours	
Antidote to Heparin: ***Protamine sulphate*** 1 mg to each 100 IU heparin → 50 mg shots every 10 minutes If given 1 or 2 hours late give half the dose		

Thrombex dose adjustment according to Creatinine Clearance

> 60	30-60	< 30
15 mg/12 hrs	1/3 of dose: 5 mg/12 hrs	شرطة ١١ 1.6 mg/12 hrs

- ♦ Antacid: Zantac 50 mg amp/8 hrs (first line) or Losec 40 mg vial /24 hrs.
- ♦ Analgesic & Antipyretic: Perfalgan 1 gm vial/ 6 hrs.

4. Treatment of co-morbidities:

e.g, hypertension →→ continue on previous treatment unless contraindicated, e.g, shock.

5. Treatment of examination findings:

e.g, wheezes →→ bronchodilators.

***In wheezy chest*:** Use corticosteroids that have a predominant glucocorticoid effect i.e, Solumedrol (not solucortef which is predominantly mineralocorticoid).
Dose: IV: 125 mg/6-8 hours, Oral: Solupred 30-60 mg/24 hours

6. Treatment of labs:

e.g, ↓↓ K^+ →→ Target 4.5 mEq/L … But in renal patients; the target is 3.5 mEq/L with cautious correction (2 ampoules then reassess). **ويتعاد في نفس اليوم**

7. Vitamins + Nutrition: especially in burn patients ... Consider formulas.

8. Ventilator care bundle:

1. Anticoagulant. 2. Antacid.
3. Oral care →→ Chlorhexidine (DG care).
4. Head elevation 30^O.
5. Daily sedation vacation unless contraindicated → status epilepticus & brain edema.
6. Assessment of readiness for weaning → If ready: spontaneous breathing trial / 24 hrs.

9. Care of comatose:

- DG care & oxypol.
- Care of bowel.

- Frequent repositioning to prevent bed sores.
- Treatment of bed sores:

  1st degree → Mebo, 2nd degree → Aeroxol, 3rd degree → Surgical debridement.
- Treatment of constipation with laxatives.
- Assessment for DVT: Well's score.

10. Physiotherapy & Out of bed:

حتى لو انت متضايق و العيان متضايق والتمريض متضايق هيقعد علي كرسي ... احنا مش جايين ننفذ طلبات المريض

11. Hopeless case:

1. الجثة سليمة 2. Pain free 3. حسن الخاتمة

Wells Clinical Prediction Rule for Deep Venous Thrombosis (DVT)

Clinical feature	Points
Active cancer (treatment within 6 months, or palliation)	1
Paralysis, paresis, or immobilization of lower extremity	1
Bedridden for more than 3 days because of surgery (within 4 weeks)	1
Localized tenderness along distribution of deep veins	1
Entire leg swollen	1
Unilateral calf swelling of greater than 3 cm (below tibial tuberosity)	1
Unilateral pitting edema	1
Collateral superficial veins	1
Alternative diagnosis as likely as or more likely than DVT	-2
Total points	

DVT = deep venous thrombosis.

Risk score interpretation (probability of DVT):

- >/=3 points: high risk (75%);
- 1 to 2 points: moderate risk (17%);
- <1 point: low risk (3%).

Richmond Agitation Sedation Scale (RASS)

Score	Term	Description
+4	Combative	Overtly combative, violent, immediate danger to staff
+3	Very agitated	Pulls or removes tube(s) or catheter(s); aggressive
+2	Agitated	Frequent non-purposeful movement, fights ventilator
+1	Restless	Anxious but movements not aggressive vigorous
0	Alert and calm	Fully conscious & not-intubated
-1	Drowsy	Not fully alert, but has sustained awakening (eye-opening/eye contact) to *voice* (>10 seconds)
-2	Light sedation	Briefly awakens with eye contact to *voice* **(<10 seconds) →→ Target score**
-3	Moderate sedation	Movement or eye opening to *voice* (but no eye contact)
-4	Deep sedation	No response to voice, but movement or eye opening to *physical* stimulation
-5	Unarousable	No response to *voice or physical* stimulation

Procedure for RASS Assessment

1. Observe patient
   a. Patient is alert, restless, or agitated. **(score 0 to +4)**
2. If not alert, state patient's name and *say* to open eyes and look at speaker.
   b. Patient awakens with sustained eye opening and eye contact. **(score –1)**
   c. Patient awakens with eye opening and eye contact, but not sustained. **(score –2)**
   d. Patient has any movement in response to voice but no eye contact. **(score –3)**
3. When no response to verbal stimulation, physically stimulate patient by shaking shoulder and/or rubbing sternum.
   e. Patient has any movement to physical stimulation. **(score –4)**
   f. Patient has no response to any stimulation. **(score –5)**

CHEST TUBE CARE

❶ Preparation for insertion

1. Respect hierarchy: حسب المكان اللي انت فيه
2. Witnessed & pain-free.
3. Patient Preparation:
   - Platelet count & INR especially if hepatic.
   - Stop clexane if therapeutic unless urgent.
4. CXR → check copula of diaphragm on right side, if elevated (liver) → نبه علي الجراح
5. Prepare for the procedure:
   - صينية تعقيم
   - برطمان مليان ٥٠٠ سم و بلاستر بالطول وكل يوم يتعلم ومتقفلش فتحات البرطمان
   - خيط Silk 1.0
6. Connect
   - الانبوبة واصلة علي الفتحة الطويلة اللي فيها عمود والزقها ببلاستر
7. CXR after insertion

🗐 In hepatic patients → pigtail is preferred over chest tube in pleural effusion due to poor healing after removal.

❷ While in place

هوا و مياه

1.ميه (pus, blood, serous)

- To avoid negative pressure pulmonary edema: Empty 500 ml/8 hrs → Then 500 ml/12 hrs → Then keep it open.
- If draining > 200 ml blood/hr after drainage of the main bulk → consider active bleeder → for surgical intervention.
- 10-15 days → empyema → افرك عشان تتشال

2. هوا

- **Surgical emphysema:**
  تتعلم بماركر كل ٦ ساعات عشان لو بتزيد ناخد بالنا
  لو راكبة وسالكة بس الـ emphysema لسه بتزيد ← consider tracheal tear
- **Air leak:** Use the lowest possible tidal volume & PEEP to allow healing.
- **Oscillation:** If stopped oscillation → either lung expansion or chest tube obstruction → Do CT chest.
- **Persistent Pneumothorax:**
  ☜اعمل اللي عليك الأول: اتأكد ان كل الخروم جوة و ان الـ chest tube نفسها جوة في الـ mediastinal window واعمل bronchoscope
  ☜ مسدودة ← insert another chest tube

☞ **Low vacuum.**

☞ Pleural thickening (mediastinal window) → decortication.

3. **Daily**
   تمرتتأكد انها oscillating والخروم جوه
   الجراح يمر
4. **Transport** تتقفل كويس أثناء النقل و متطلعش فوق مستوي العيان

❸ For removal

1. Clamp for 4-5 hours before removal then do CXR → remove then do another CXR.

2. Any diminished air entry → consider pneumothorax (once pneumothorax always pneumothorax).

Ventilation

$$P = Peep + V \times 1/C + RF$$

P is peak pressure
V x 1/C is the difference between plateau & peep
RF is the difference between peak & plateau

Indications of intubation (Inability to protect the airway)

1. Anesthesia.
2. Bulbar palsy.
3. GCS ≤ 8.
4. Continuous trickling, e.g, fractured nose.
5. Capacious secretions and inability to cough.

Indications of ventilation

1. Impaired mechanics : RR > 35/min , VC < 15 ml/kg, Inspiratory force < 25 cmH_2O.
2. Impaired oxygenation: PaO_2 < 60 mmHg on O_2 mask, shunting > 20% , $P(A\text{-}a)O_2$ > 350 mmHg. with FiO_2 = 1.
3. Impaired ventilation: $PaCO_2$ > 60 mmHg with no COPD, TV < 5 ml/kg, VD-VT ratio < 0.6.

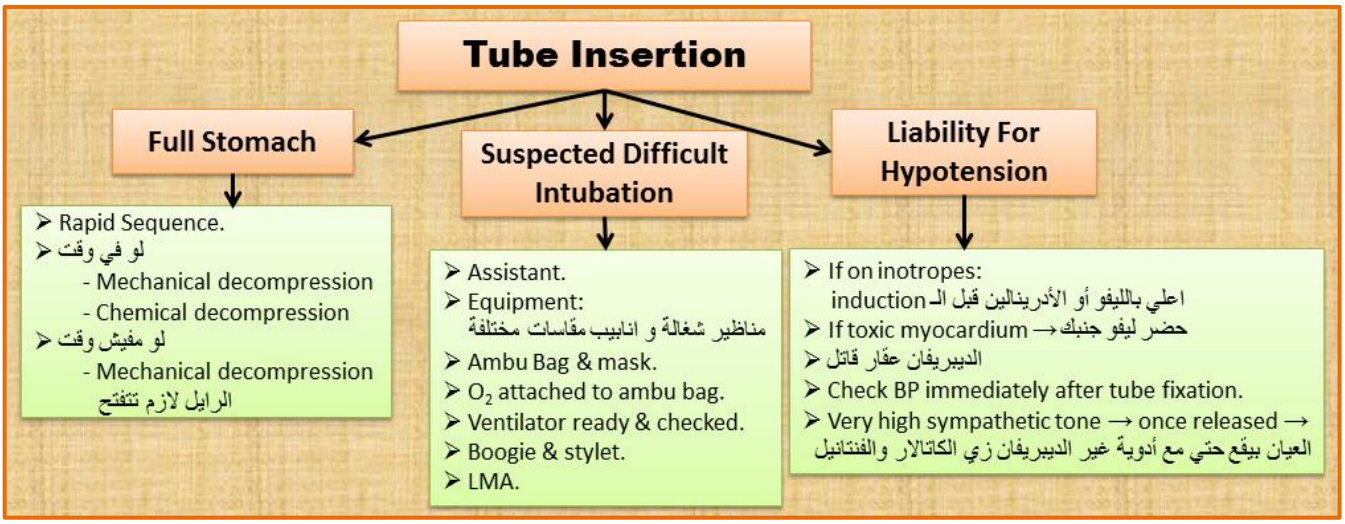
Criteria of weaning

Non Respiratory	Respiratory
1. CNS: GCS > 8 2. CVS: – Minimal dose of inotropes – HR doesn't increase > 20% from baseline 3. GIT: not abdominal compartmental 4. Metabolic: absence of any of the following: – Fever/ Hypothermia – Metabolic acidosis – Severe anemia – Electrolyte disturbances – Hypoglycemia	1. PF ratio > 200 2. Rapid Shallow Breathing Index (RSBI): Respiratory rate / Volume in liters > 105 →weaning will fail. < 105 →good chance for successful weaning. < 70 → higher chance of successful weaning. 3. Minimal or no secretions. 4. Adequate cough reflex. 5. Create negative pressure > 20 cmH_2O . 6. pH not less than 7. 7. PCO_2 < 60 in non COPD patients. In COPD patients hypercarbia is allowed till it starts affecting the pH.

Difficult weaning

- Patients with multiple failed weaning trials.
- How to wean:
  - Pressure support 5, PEEP 5 for 1 hour.
  - T-tube for 1 hour.
  - Controlled for 1 hour.

  Then extubate.



Tube Exchange

1. اعلى بـ FiO_2 لـ 100 %.
2. أتأكد إنه بياخد volumes كويسة.
3. The same as tube insertion
4. والأنبوبة جوه هات view.
5. شفط كويس من الـ oropharynx.
6. جهز قسطرة تانية معاك.
7. بشيل الأنبوبة وأدخل الأنبوبة الجديدة للآخر ← لو مدخلتش يبقى في distal obstruction.
8. انفخ الـ cuff ومتنساش تنزل بـ FiO_2.
9. لو في excessive saliva ← ثبت ببلاستر الأول تخشينة تحت الشاش.

Tube Obstruction

1. Exclude other causes of high peak (DD of hypoxia).
2. Ambu bag with saline.
3. Close the pressure releasing valve.
4. Make sure valve at the back of ambu bag is working.
3. FiberOptic ***مفيش ؟***
4. هات أنبوبة مقاسها أصغر ودخلها من الأنبوبة اللي راكبة (rolling movement) ووصلها على شفاط واخرج بيها.
خلي بالك ده ممكن يعمل pneumothorax .
5. Cardiothoracic: Rigid bronchoscopy

.

Armored ETT are used in: extensive movement, shared airway & abnormal position.

Nasal ETT fixation length: 3-5 cm more than Oral ETT.

Types of Endotracheal Tubes:

- According to material: PVC, Rubber, Metal.
- According to insertion: Nasal, Oral, Submental.
- According to cuff: Cuffed, Uncuffed.
- According to lumen: Single, Double.

➢ **Specific precautions for intubated pediatrics (small ETT):**

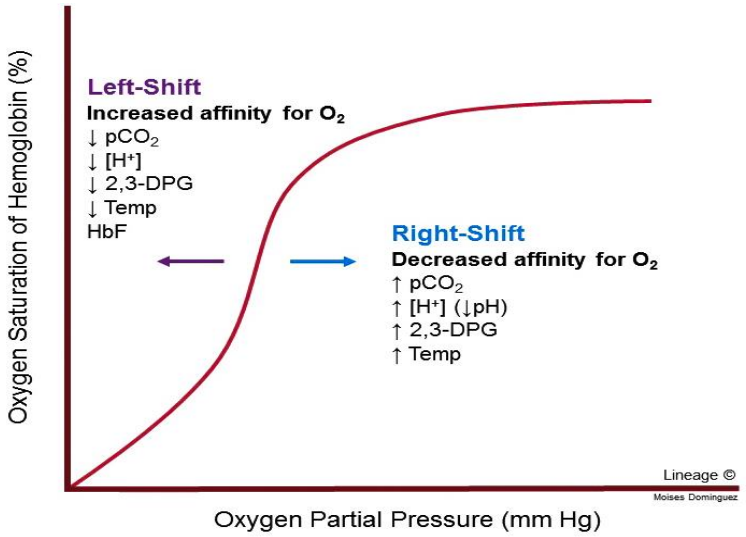
- Suction every 2 hours بنفسك
- Humidifier مليان و شغال
- Bronchodilators
- Solucortef لو أمكن

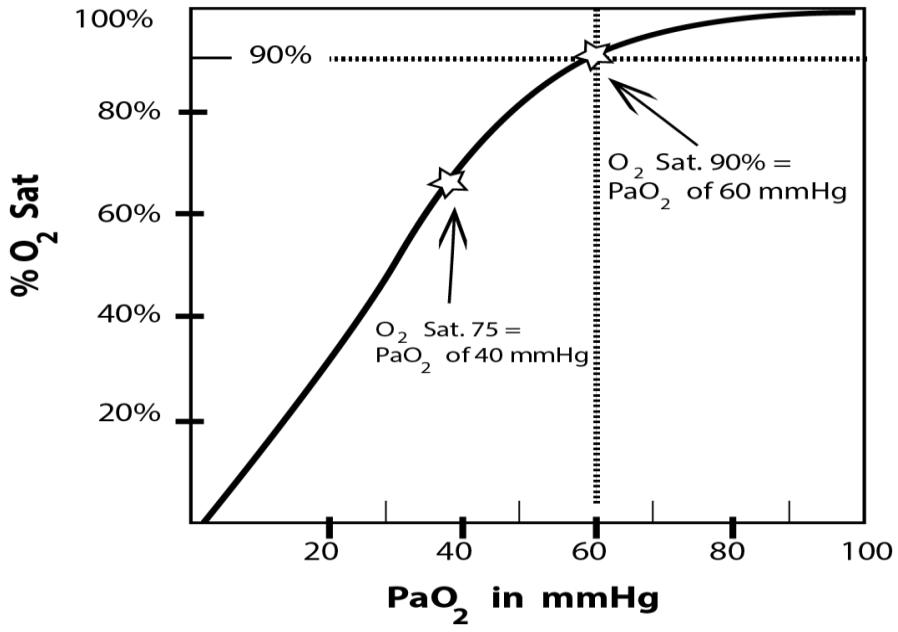
- لو قلقان منه حطه على VCV وارفع الـ pmax خليه 100 عشان لو اتسد .
- Tracheostomy: wash twice per day after day 6 .

Ventilatory Settings

1. Spontaneous
2. Controlled
   - PCV
   - FiO2 100% if hypoxic then decrease gradullay.
     If not hypoxic decrease rapidly to 40 %.
   - If FiO_2 > 40% → PEEP has to be > 5
     Except: Bronchopleural fistula & Right side pathology.
   - TV → 6-8 ml/kg according to CO_2 & pH.
   - If VCV → apply inspiratory pause 5-10.
   - Rate & I:E ratio → inspiratory time 0.8-1.2.
   - Pmax 100 in: asthmatic, CPR, during bronchoscopy & pediatrics..
   - Pmax → represents airway pressure.
   - Plateau → represents alveolar pressure.
   - Apnea time → 20-30 seconds.
     If being weaned on CPAP.
     If failed → increase apnea time up to 1 minute (you can leave the patient).
     → SIMV Rate 3 (stay next to patient for 15 minutes).

Oxy-hemoglobin dissociation curve





- ♦ PO_2: 27 → SO_2: 50% (P50) = Arterial PO_2 at which 50% of Hb is oxygenated.
- ♦ PO_2: 40 → SO_2: 70-75% = Mixed venous tension.
- ♦ PO_2: 60 → SO_2: 90% = Least accepted SO_2 for discharge.
- ♦ PO_2: 100 → SO_2: 97% = Arterial point.

☜ لو الـ FiO_2 اللي العيان عليه 0.4 والـ SO_2 على المونيتور 90 أو أكثر ←← يبقى الـ PO_2 أكيد أكثر من 60 ← وبالتالي أكيد الـ PF ratio أكثر من 150 (60/0.4) من غير ما تعمل ABG .

☜ لو خليت الـ FiO_2 اللي العيان عليه 0.3 والـ SO_2 على المونيتور لسه 90 أو أكثر ←← يبقى الـ PO_2 أكيد لسه أكثر من 60 ← وبالتالي أكيد الـ PF ratio أكثر من 200 (60/0.3) من غير ما تعمل ABG .

Ventilator graphics

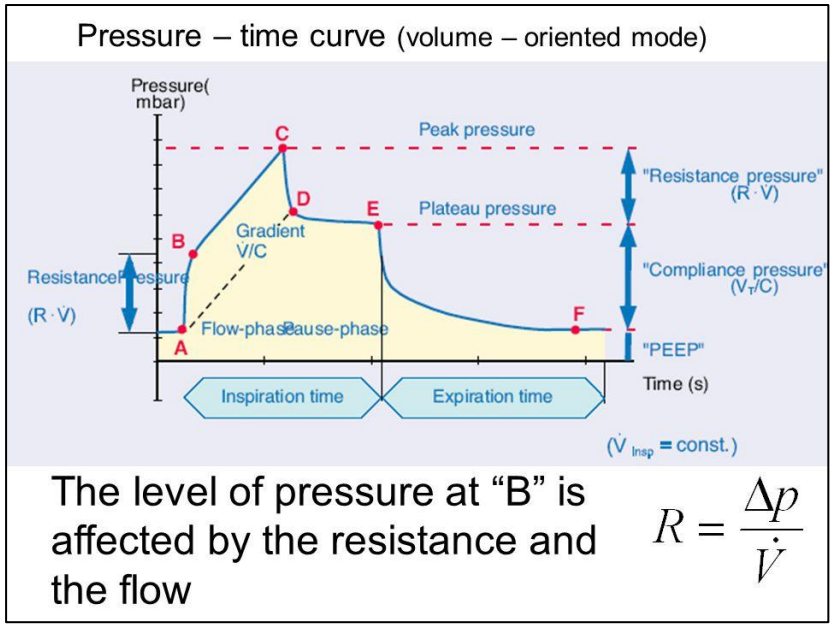
Curves: Pressure, flow & volume against time.

Loops: Flow-volume & pressure-volume loops (data interpretation).

Curves

1.Pressure-time curve :

a) Volume controlled ventilation:

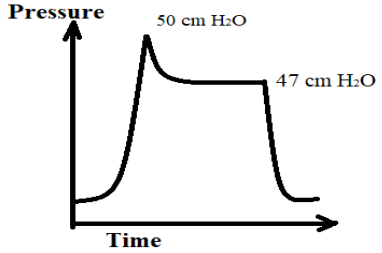
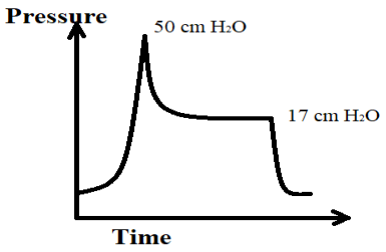
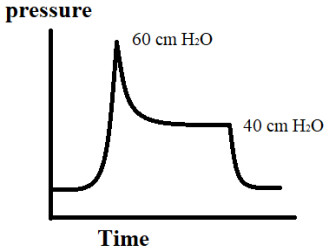


- ♦ A ---- B: Resistance in the system (hoses & lungs), so pressure increases dramatically.
- ♦ B ---- C: pressure created by lung compliance, so pressure increases gradually.
- ♦ At point C: No further flow as the ventilator delivered the set tidal volume, so pressure quickly falls to plateau pressure, the degree of fall equals the rise of pressure caused by the resistance at the beginning of inspiration... i.e, A ---- B = C ---- D = resistance pressure.

☞ N.B: Point C = peak pressure = PEEP + lung compliance + resistance pressure.

- ♦ D ---- E: May be a slight decrease in pressure → leak is a possible reason for this.
- ♦ At point E: Termination of inspiratory time, expiratory valve opens & drop of pressure down to PEEP occurs.

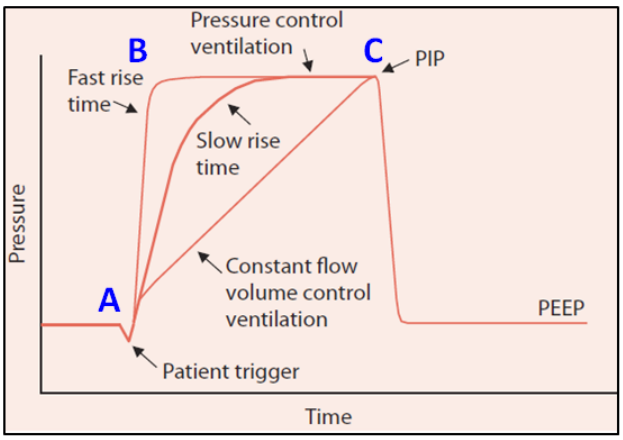
☞ N.B: Peak pressure – plateau pressure = ≤ 4 cmH2O

Lung compliance disease	Resistance problem	Combined
		

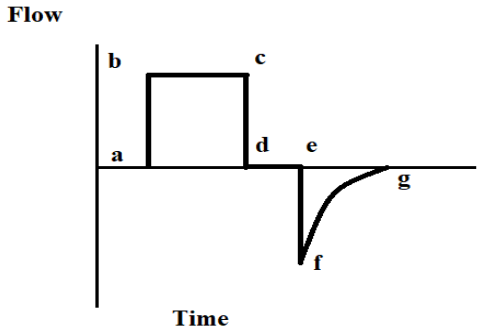
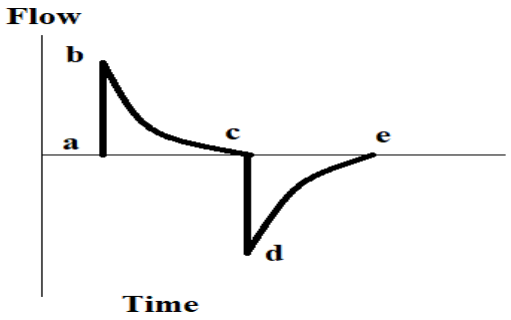
➢ Static compliance = Δ V / Δ P →→ TV / (plateau pressure – PEEP)
➢ Dynamic compliance = ΔV / Δ P →→ TV / (peak pressure – PEEP)

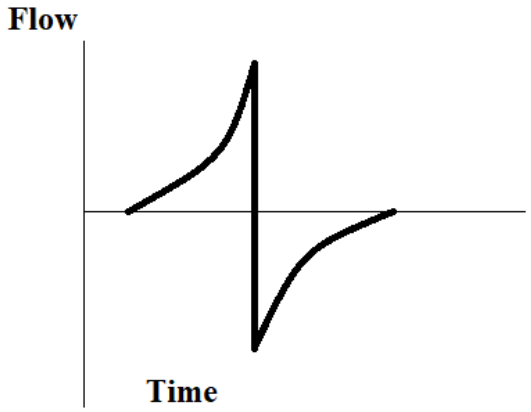
b) Pressure controlled ventilation

♦ At first, the ventilator delivers a volume to reach target pressure, so from A---- B there is a sharp rise in pressure.
♦ Point B ---- Inspiratory pressure.
♦ From B ---- C: It is not a pause!! but the pressure doesn't rise or fall due to decelerating flow to maintain pressure inside the lung constant during inspiratory time.
♦ At point C ---- the expiratory valve opens & the pressure falls to PEEP and expiration begins.

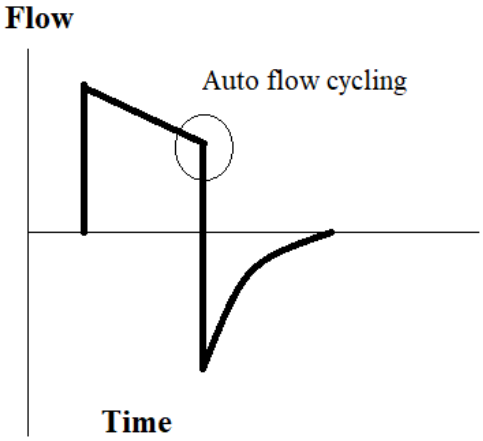


2. Flow time curve :

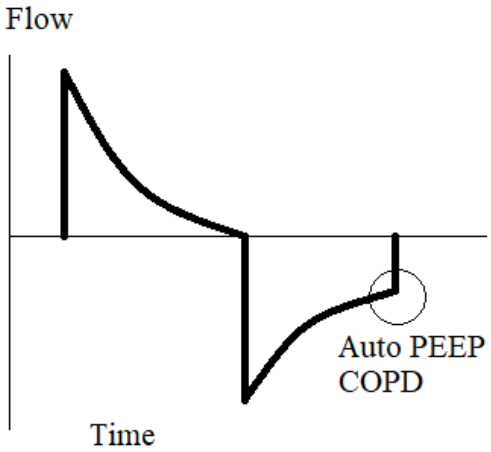
Volume controlled ventilation	Pressure controlled ventilation
♦ The flow during inspiration is constant flow . ♦ From D ---- E it is inspiratory pause . ♦ The flow during expiration is decelerating flow (passive expiration).	♦ The flow during inspiration is decelerating flow . ♦ The flow during expiration is decelerating flow (passive expiration). ♦ Accelerating flow
	



Interpterion

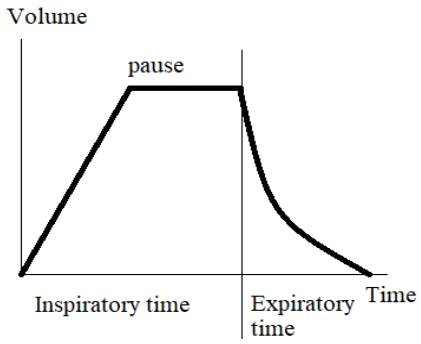
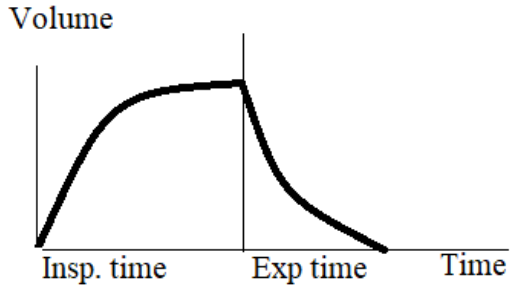


Auto cycling , Flow cycling



Auto PEEP – COPD

3. Volume time curve :

Volume controlled ventilation	Pressure controlled ventilation
♦ The flow during inspiration is constant flow . ♦ From D ---- E it is inspiratory pause . ♦ The flow during expiration is decelerating flow (passive expiration).	♦ The flow during inspiration is decelerating flow . ♦ The flow during expiration is decelerating flow (passive expiration). ♦ Accelerating flow .
	

Mechanical ventilation

Classification :

Positive pressure vs negative pressure ventilation :

1. **Negative pressure ventilators :**
   Iron Lung: pastly used in the era of poliomyelitis & recently in patients with neuromuscular disorders.
   Disadvantages: Patient handling, Patient discomfort, No airway protection .
2. **Positive pressure ventilation**
   Gas is forced into the patient lung by mechanical means .
   This can be : invasive → ETT or non-invasive → CPAP mask (Face or Nasal)

Volume targeted VS Pressure limited ventilation

	Volume targeted ventilation	Pressure limited ventilation
Pressure	P. Peak P. Plateau	P. Plateau
Flow	Constant flow	Variable decelerating
Advantages	Guarantee ventilation	Limiting pressure Flow pattern allows better ventilation Patient satisfaction.
Disadvantages	Allows pressure to increase	Cannot guarantee ventilation

Components of mechanical breath :

1. Trigger :

- By mechanical ventilator : time triggering .
- By the patient :

Type	Flow triggering	Pressure triggering
Level	2 L/min	-2 cmH2O
Mechanics	Inspiratory valve partially closed	Inspiratory valve completely closed

- Effect of high level triggering ----- fighting of the ventilator
- Effect of low level triggering ----- Auto triggering .

2. Limit :

- Volume in volume targeted ventilation .
- Pressure in pressure targeted ventilation .

3. Cycling: shift from expiration to inspiration

- I:E ratio (inspiratory time): time based.
- Flow cycling: in spontaneous mode, when flow reaches 25% of the initial flow (CPAP, SIMV, BIPAP).

Ventilator parameters

1. Tidal volume (TV): volume modes and pressure controlled volume guaranteed.
2. Inspiratory pressure (Pinsp): pressure modes .
3. Respiratory rate (RR).
4. Fraction of inspired oxygen (FiO_2).
5. I:E ratio.
6. Trigger (in assist control or spontaneous modes).
7. P max (P limit) .

Modes of mechanical ventilation

Based on triggering :

- Controlled ventilation ------- only time triggering.
- Assist control ventilation ------- time ± flow or pressure triggering.

Pressure or volume modes .

	Trigger	Limit	cycling	TV	PS	Pinsp	RR	I:E	PEEP	Pmax	FiO_2
VCV	Time	Volume	Time	√	_	_	√	√	√	√	√
aVCV	Time ±flow or Press	Volume	Time	√	_	_	√	√	√	√	√
SIMV-VC	Time ±flow or Press	V±P	Time ± Flow	√	√	_	√	√	√	√	√
PCV	Time	Press	Time	_	_	√	√	√	√	_	√
aPCV	Time ±flow or Press	Press	Time	_	_	√	√	√	√	_	√
SIMV-PC	Time ±flow or Press	Press	Time ± Flow	_	√	√	√	√	√	_	√
PCVG	Time ±flow or Press	P±V	Time	√	_	_	√	√	√	_	√
BiPAP	Time ±flow or Press	Press	Time ± Flow	_	√	√	√	√	√	_	√
APRV	Time ±flow or Press	Press	Time ± Flow	_	√	√	√	√	√	_	√
CPAP	Flow or Press	Press	Flow	_	√	_	_	_	√	_	√

Oxygen cascade

Dalton's law of partial pressure :

The total pressure of a mixture of gases is equal to the sum of the partial pressure of the individual constituent gases. i.e, P total = P1+P2+P3

Clinical application

Ambient air pressure = PO_2 + PN_2 + P water vapour
So PO_2= (ambient air pressure - saturated vapour pressure)*21/100 = (760 – 50) *21/100 = 150 mmHg
PN_2 = 710 * 80/100 = 600 mmHg

1. PO_2 in the trachea = 150 mmHg
   Pressure of oxygen in the alveoli = 150 – (PCO_2 / respiratory quotient)
   While PCO_2 = 35 mmHg
   RQ = CO_2 production / O_2 consumption = 200/250=0.8
   So , PaO_2 = 150 – 35/0.8 = 110 mmHg

   N.B - Carbs increases CO_2 production -------- RQ = 1
   - Ptns decreases CO_2 production -------- RQ = 0.7
   - Increase CO_2 ------- decreases alveolar O_2 tension --------decreases saturation
2. Pulmonary end capillary O_2 tension :
   In practice, it is considered to be PaO_2 provided ACM is normal
   Arterial O_2 tension: PaO_2 = 102 – age/3
   N.B 110-------102 How?
   1. Basal atelectasis which increase with age .
   2. Bronchial drainage .
   3. Thesbesian veins (venous drainage of the heart).
   4. Shunting .
3. Mixed venous O_2 tension ------ 40 mmHg .
   N.B
   Mixed venous SO_2 = 70% (pulmonary artery).
   Central venous SO_2 = 65% (superior vena cava only).
   In anesthetised patient :
   Mixed venous > 70 % Central venous > 65 %
   As in anesthetised patients have low cerebral metabolic rate.

Expected arterial O2 tension = FiO2 * 5

e.g if FiO2 40% , so PaO2 = 40*5=200 mmHg

Hypoxic pulmonary vasoconstriction (HPV)

Alveoli filled with secretion →→ vasoconstriction.

- Direct blood flow to better oxygenated parts of the lung .
- The major stimulus is alveolar hypoxia, so increasing the FiO_2 →→ blunting of HPV →→ ↓↓ arterial O_2 tension.
- Every 10% increase above FiO_2 40% →→ ↓↓ expected arterial O_2 tension by 5-10 mmHg.

e.g : 100% ----- 6 times increases by 10% above 40%

- Functional residual capacity = Residual volume + Expiratory Reserve Volume = 2500 ml
- Preoxygenation allows 10 minutes before desaturation as O_2 consumption is 250ml / min
- Average rise of CO_2 in 1st minute is 6 mmHg, then 4 mmHg every minute after.
- CO_2 after 10 minutes = 42 mmHg + already existing 30 = 72 mmHg.

ARDS

Definition

Acute persistent hypoxia with bilateral diffuse lung infiltrate due to non-cardiogenic etiology.

1. Acute → within 7 days from the triggering factor, commonly in the first 3 days.
2. Persistent hypoxia → PO_2/FiO_2 → < 300.
   Mild: 200-300 Moderate: 100-200 Severe: < 100
3. Bilateral diffuse lung infiltrates in CXR.
4. Non-cardiogenic etiology. (Echo + brain natri-uretic peptide).

± 5. Cause

Etiology

a) Pulmonary

♦ Aspiration & pneumonia

b) Extra-pulmonary

♦ **Sepsis & Trauma** → the most common.
♦ **P**ancreatitis, purpura, burn, blood transfusion (massive).
♦ **C**ardiopulmonary bypass
♦ **D**rugs: Oxygen, cocaine, heroin.
♦ **E**mbolism: Fat, amniotic, repetitive minor venous emboli from DVT.

Differential diagnosis of hypoxia

1. Chest auscultation:
★ Diminished unilateral: collapse - endobronchial tube - دم - ميه - هواء
★ Diminished bilateral: pleural effusion → treated by PEEP + lasix + cause.

2. Imaging:
♦ CXR or CT chest → pneumonia, pneumothorax, ARDS, endobronchial tube ± Lung ultrasound.
♦ Lung ultrasound → pneumothorax .

3. Echo:
♦ Right side: Dilated in case of pulmonary embolism.
♦ Left side: Poor contractility is suggestive of heart failure & pulmonary edema.

4. Numerics of ventilator:
♦ Check the peak airway pressure, plateau pressure & the tidal volume.
- ↑ peak & plateau → ↓↓ compliance.
- ↑ peak & normal plateau → obstruction.

➢ Pleural effusion → chest tube ركب → ساعات 6 سم واقفلها 500 سيبها تنزل → to avoid negative pressure pulmonary edema + diuretics + Lasix
➢ Any hemothorax is an indication for chest tube as it doesn't resolve with diuretics.

Clinical picture

♦ Clinical picture of the cause.
♦ Rapidly progressive respiratory distress (dyspnea & tachypnea).
♦ Early: hypoxia, late: hypercarbia.
♦ ABG → acute severe hypoxemia.
♦ PFTs → restrictive pattern.
♦ CXR → bilateral diffuse infiltration.
♦ Complications → DIC, ventricular arrhythmia or AKI.

Prognosis

- Mortality: 30% either due to the primary cause or due to complications (MOSF).

Management

1) **ABC** (control of BP and saturation within 30 minutes with adequate blood gases and ventilator parameters).
2) **Definitive treatment.**
3) **Treatment of cause.**
4) **Treatment of complications.**

Definitive treatment

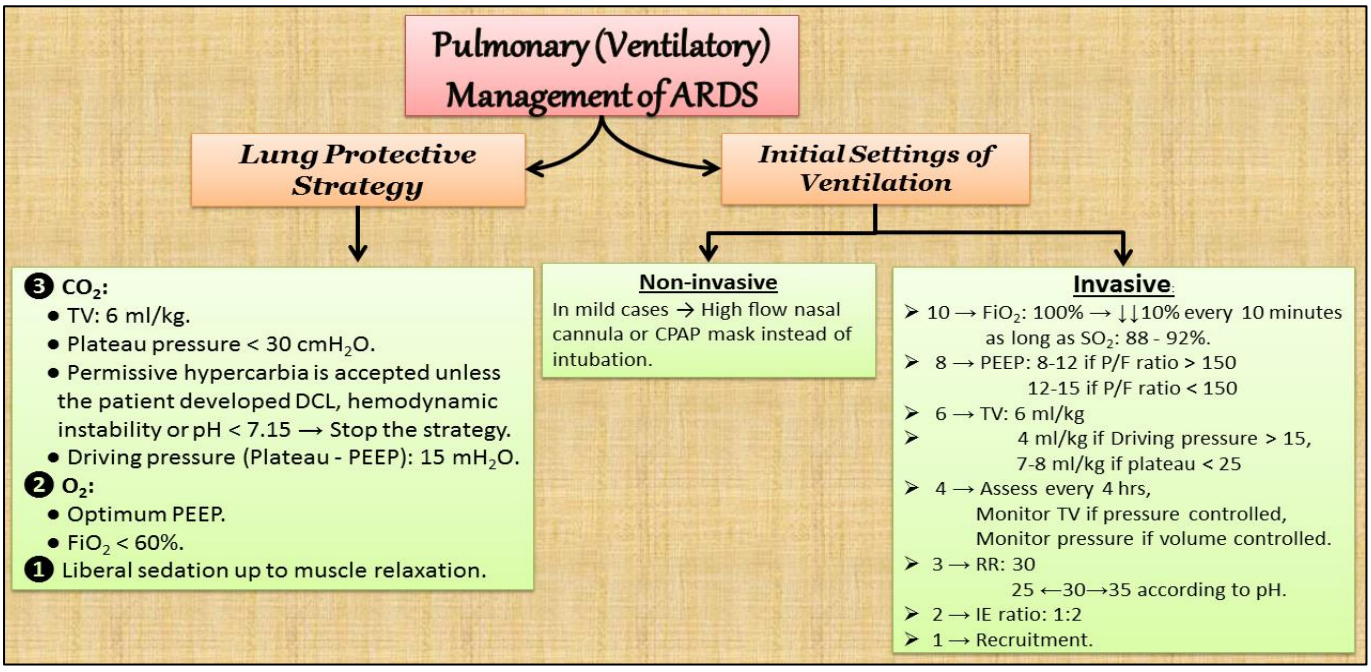
a) Extra-pulmonary

1. **Solumedrol** →→ 1 mg/kg/day for 5-7 days or IV infusion ... Then 0.5 mg/kg/day for 5-7 days Then 0.25 mg/kg/day for 5-7 days... Then 0.125 mg/kg/day for 3 days.
2. **Liberal sedation up to muscle relaxation (tracium)** for 48 hours (within 24-48 hours from the onset of ARDS. Performed only if P/F ratio < 150.
3. **Negative balance using diuretics.**
4. **Nitric oxide inhalation**: Selective pulmonary VD i.e. to ventilated alveoli, so shifts blood from non-ventilated alveoli to ventilated ones.
   Rapidly metabolized → so it acts on lungs only and doesn't reach systemic circulation.
5. **Extra-corporeal membrane oxygenation (ECMO).**
6. **Prone position** for 16 hours daily for 3 days → Only if P/F ratio < 150.
   The main bulk of the lungs lies posteriorly → So, prone position provides better ventilation to larger portions of the lungs.

b) Pulmonary

- Non-invasive: in mild cases.
- Invasive (intubation): in severe hypoxemia.

> Ventilator-induced lung injury in ARDS: volutrauma, barotrauma, atelectrauma, biotrauma & oxygen toxicity → avoided by lung protective strategy.



Recruitment	
Indications	Severe ARDS: P/F ratio < 150 … Done in the first 3 days.
Contraindications	- Chest tube (pneumothorax) - Broncho-pleural fistula - Late ARDS > 5 days - Cardiac patient (hemodynamic instability) - Failure of previous recruitment
Preparation	- Arterial line + baseline ABG. - FiO_2: 100%. - Deep sedation & relaxation. - Normalize BP: If borderline → Give fluids if fluid responder → Inotropes (minimal dose) if non-responder
Pre-test	PEEP 15-20 for 15 minutes. Look at PO_2, SO_2, P/F ratio & oxygenation index. If > ↑↑ 5% → Recruitable.
Methods	♦ PEEP 40 for 40 seconds → بطلت بس بنستخدمها في العمليات ♦ Driving pressure 15 cmH_2O … 8 minutes divided into 4 steps.
Complications	- Pneumothorax - Hemodynamic instability

Duration	Driving pressure	I:E ratio	RR	FiO_2	PEEP
2 minutes	15	1 : 1	10	1	20
2 minutes	15	1 : 1	10	1	25
2 minutes	15	1 : 1	10	1	30
2 minutes	15	1 : 1	10	1	20

♦ Then: ABG → If $PO_2 + PCO_2 > 400$ → This means that 95% of alveoli are opened.

♦ Calculate the optimum PEEP:

انزل بالـ PEEP بمقدار 2 لمدة 3-5 دقائق واسحب ABG وشوف الـ PO_2 ← لو قل بمقدار أقل من 10% ← انزل بالـ PEEP كمان 2 لمدة 3-5 دقائق وعيد الـ ABG ← لو الـ PO_2 قل بمقدار أكثر من 10% من اللي قبله يبقى ده الـ Closing pressure ← اعلى فوقه بـ 2 وثبت على كده وهو ده الـ Optimum PEEP وليكن مثلاً 16 ... بعد كده عيد الأربع خطوات تاني وآخر PEEP في الخطوة الرابعة يبقى 16 مش 20.

♦ Then: Reset the ventilator parameters back to ARDS ones.

PEEP: 16 (optimum PEEP),
I:E ratio 1:2
RR:30
TV: 6 ml/kg
FiO2: the least achieving $SO_2 > 88\%$
Plateau pressure: < 30 cmH_2O

♦ Then: Keep the patient on the optimum PEEP till FiO_2 can be decreased to 40% with $SO_2 > 88\%$ → then PEEP can be decreased together with solumedrol & negative balance.

♦ If ABG from the start showed that $PO_2 + PCO_2 < 400$ → Repeat recruitment steps for 3 times → If failed → Not recruitable → for prone position.

OXYGEN THERAPY

Nasal cannula

- Adjust to 0.5-6 L/min to avoid nasal dryness.
- Gives FiO_2 24 - 40%.

High flow nasal cannula (+ humidifier)

- Adjust to 20-100 L/min.
- Gives FiO_2 21 - 100%.
- Can be used as alternative to CPAP mask with better patient compliance.

Oxygen Mask

1. **Open mask**
   - When set at 6 L/min it gives FiO_2 24%.
   - Every additional 1 L/min →↑↑ FiO_2 by 3%.
2. **Venturi mask**
   - Up to FiO_2 60%.
   - Each color is labelled for X L/min gives Y FiO_2

☜ الماسك بيوصل علي جزء ملون، كل لون بيبقي مكتوب علي يتضبط علي كام لتر فيديك كام أكسجين .

3. **Non rebreathing Mask with reservoir bag**
   - Gives FiO_2 80 - 100%.

CPAP mask

➢ Indications:

- COPD
- Acute pulmonary edema
- Early ARDS
- Obstructive sleep apnea

BLOOD GASES

pH "power of hydrogen"

- It is the negative log of H^+ ions to the power 10 .
- Why to the power of 10? → because H+ concentration = 40 nano Eq/L "small number so, power of 10 → readable
- **Negative** means that pH values get lower as the H^+ ions concentration increases.
- **Logarithmic** means that shift of pH by 1 represents a 10 fold change in H^+ ions concentration e.g, 7 is 10 times more acidic than 8.

Normal values

PH: 7.4 + 0,04 PCO_2: 40+4 PO_2: 102 - $(\frac{Age}{3})$

HCO_3^-: 22 + 2 Lactate: < 2 mEq/L Cl^-: 100+4

Anion gap: 12-18 mEq

Death occurs at pH less than 6.8 or more than 7.8 due to enzymatic dysfunction.

Compensatory mechanisms

1. Buffers

- HCO_3^- pka: 6.1 + 1 → so it is more effective at pH less than 7.1 .
- Hemoglobin - Proteins - Others.

2. Respiratory

- Takes one hour from metabolic acidosis "tachypnea".
- Takes one hour from metabolic alkalosis "bradypnea".
- Respiratory compensation is more effective in metabolic acidosis.
- In case of bradypnea →→↑↑ CO_2 & ↓↓O_2 → stimulate breathing.
- ↑PCO_2 by 1 mmHg →→ ↑↑ minute ventilation by 1 liter.

3. Renal

- Takes one day to start with maximum effect after 3 days.
- It includes : ☞ Reabsorption of HCO_3^-
  ☞ Excretion of titratable acids
  ☞ Formation of ammonia

Sequence to read the blood gases

1. **Oxygenation & ventilation.**
2. **Metabolic component**
3. **Electrolytes & Hb** "*if caliberated*"
4. **Anion gap.**

- Arterial or venous: compare with monitor saturation ... If arterial→ assess the PF ratio .

أي عيان obese :

1. لما يصحى قعده 90° وحطله oxygen mask وقوله يكح .
2. لو الـ PF ratio مش كويس اعمله recruitment .

Compensation

Respiratory	Metabolic acidosis: Expected ↓CO_2 → 1.2 x △ HCO_3^- Metabolic alkalosis: Expected ↓CO_2 → 0.7 x △ HCO_3^-
Metabolic	Respiratory acidosis : Expected ↑ HCO_3^- : Acute: 1 for each 10 mmHg increase in CO_2 . Chronic: 4 for each 10 mmHg increase in CO_2 . Respiratory alkalosis : Expected ↓ HCO_3^- : Acute: 2 for each 10 mmHg increase in CO_2 . Chronic: 5 for each 10 mmHg increase in CO_2 .

Effects of acid-base disturbance on different organs

	Acidosis	Alkalosis
CNS	- Cerebral vasodilatation. - CNS depression .	Cerebral vasoconstriction. CNS excitation .
Respiratory	- Bronchodilatation. - Shift of oxy-hemoglobin dissociation curve to the right. - Vasoconstriction of bronchial vessels . - Respiratory center stimulation.	- Bronchoconstriction. - Shift of oxy-hemoglobin dissociation curve to the left. - Vasodilatation of bronchial vessels. - Respiratory center depression .
CVS	- PCO_2:"60-80"→ stimulation PCO_2: > 80 → depression Early → stimulation occurs due to release of catecholamines. Late → depression occurs due to myocardial depression, vasomotor center inhibition and vasodilatation.	- Arrhythmias due to hypokalemia & ↓ ionized calcium.
Electrolytes	↑K^+ & ↑ ionized calcium. ↓ pH by 0.1 → ↑ serum K^+ by 0.6 mEq/L.	↓K^+ & ↓ ionized calcium.

Metabolic acidosis

- ↓pH, ↓PCO_2 , ↓HCO_3^-
- Respiratory compensation (△ PCO_2) = 1.2 x △ HCO_3^-
- **Anion gap:** used to determine if metabolic acidosis is due to an accumulation of acids (high anion gap) as in DKA or a primary loss of bicarbonate (normal anion gap) as in diarrhea.
  To achieve electrochemical balance, the concentration of negatively charged anions must equal the concentration of positively charged cations.
  $Na + UC = (Cl + HCO_3) + UA$ →→→ $Na – (Cl + HCO_3) = UA – UC$
  UA – UC is the anion gap (AG) and = $Na – (Cl + HCO_3)$
  Unmeasured anions = 23 mEq/L: Albumin(15), Organic acids(5), Phosphate(2) & Sulphate(1)
  Unmeasured cations = 11 mEq/L: Calcium(5), Potassium(4.5) & Magnesium(1.5)
  Normal AG = 23 - 11 = 12 ± 4.
- ↓ Albumin by 1 gm/dl → ↓ anion gap by 2.5 → this could mask the presence of an unmeasured anion (e.g., lactate) that is contributing to a metabolic acidosis → So: calculate the corrected AG →→→ **Corrected AG = AG + [2.5 × (4.5 –albumin in g/dL)].**
- **The Gap-gap Ratio:** AG Excess/HCO_3 Deficit $= \frac{AG-12}{24-HCO3}$

Significance: If metabolic acidosis is due to excess acids only (high AG metabolic acidosis) only → the increase of AG will be equivalent to the decrease of HCO_3 → So, the Gap-Gap ratio will be 1.

In case of co-existence of high AG metabolic acidosis & normal AG metabolic acidosis → the decrease in HCO_3 will be greater than the increase in AG and the gap-gap ratio will be < 1.

In case of co-existence of high AG metabolic acidosis with metabolic alkalosis (nasogastric drainage or diuretics) → the decrease in HCO3 will be less than the increase in AG and the gap-gap ratio will be > 1.

➢ **Types of metabolic acidosis:**

1. High anion gap metabolic acidosis: It occurs as a result of excess acids:
   - ♦ Exogenous: methanol, ethanol & salicylates (late).
   - ♦ Endogenous:
     - ☞ Increased production: ketoacidosis (DKA), lactic acidosis (sepsis, metformin, starvation & hypoperfusion).
     - ☞ Decreased excretion: acute & chronic renal failure.

   The Most common cause → Renal impairment.

2. Normal anion gap metabolic acidosis (Hyperchloremic metabolic acidosis):

   It occurs as a result of loss of alkali.

   Loss of bicarbonate is balanced by increased renal reabsorption of chloride ions to maintain electrical charge neutrality.

   ☞ Causes: Ileostomy, pancreatic fistula & diarrhea,
   TPN → panamin contains high chloride content,
   Carbonic anhydrase inhibitor (Acetazolamide) → acidsosis + $\downarrow K^+$ **الوحيد**
   Renal tubular acidosis,
   Uretero-enterostomy, ileal conduit (absorption of chloride from urine)
   Infusion of large volume of saline.

➢ **Clinical picture**: clinical picture of the cause + effects of acidosis on different organs.

➢ **Treatment**: 1. ABC
2. Treatment of the cause
3. If PH < 7.1 → correct HCO_3^-: ⅓ deficit x body weight → half correction
   Or ⅓ base excess x body weight.

★ **Base excess:**

- Amount of acid or alkali to be added to blood at temperature 37oc & normal oxygen saturation to normalize the pH.
- If –ve → acidosis, if +ve → alkalosis
- Normally it is - 2 to + 2 mEq/L
- Metabolic alkalosis > +2 , Metabolic acidosis < -2

★ **Dose of HCO_3^- in pediatrics** → 1-2 mEq/kg.

★ **Wait before giving HCO_3^- :**

- Mild acidosis is useful → effect on organs
- NaHCO3: in neonates → hypernatremia & ICH,
  in adults → ↑CO_2 → delay the weaning & intracellular acidosis.
- Give $NaHCO_3$ when pH is < 7.1 .... or < 7 in DKA as it is responds rapidly to fluids & insulin.
- If renal cause → dialysis is indicated.

N.B: Carbicarb → has no side effects but not present in Egypt.

Metabolic alkalosis

- ↑pH, ↑PCO_2 , ↑HCO_3^-
- Respiratory compensation (△ PCO_2) = 0.7 x △ HCO_3^-
- **Causes:**

Chloride Sensitive "High chloride in urine"	Chloride Resistant "Low chloride in urine"	Miscellaneous
Diuretics Fistula Vomiting & nasogastric drainage Chloride diarrhea	- Hypokalemia, e.g; Conn's & Cushing $	Bicarbonate Milk alkali syndrome

N.B : The most common cause of chronic hypokalemia is hypomagnesemia.

- **Clinical picture**: clinical picture of the cause + effects of alkalosis on different organs.
- **Treatment**:
  1. ABC.
  2. Treatment of the cause.
  3. If chloride sensitive → ⅓ deficit x body weight.

     If pH > 7.6 and the patient is not responding to treatment → dialysis.

Respiratory acidosis

- ↓pH, ↑PCO_2 , ↑HCO_3^-
- **Causes**:
  1. Increased production:
     - ♦ Exogenous: CO2 insufflation -TPN (High CHO content) -Bicarb.
     - ♦ Endogenous:
       - ☞ Tourniquet release, malignant hyperthermia (sux), fever

         Neuroleptic malignant syndrome (anti-psychotic drugs) & thyroid storm.
  2. Decreased elimination = Hypoventiation.
     - ♦ Obstructive : Upper airway: foreign body & laryngeal spasm.

       Lower airway: COPD & bronchospasm.
     - ♦ Restrictive:

       Neuromuscular diseases:
       - Central: Hemorrhage, tumor, trauma, drugs
       - Spinal cord: Trauma
       - Ganglion: Poliomyelitis
       - Nerve: Neuropathy
       - Neuromuscular junction: Myasthenia
       - Muscle: Myopathy

       ↓↓ Compliance:
       - Lung: Interstitial pulmonary fibrosis, pulmonary edema (late)
       - Pleura: Pleural effusion, pneumothorax
       - Thoracic wall: Kyphoscoliosis
       - Soft tissue: Morbid obesity (Pickwickian syndrome)
     - ♦ **جهاز بايظ**: CO_2 rebreathing : exhausted soda lime, valve malfunction.
     - ♦ **دكتور لا مؤاخذة**: Inadequate ventilation parameters.

       لو نيم طفل وبعده حالة adult ونسى يعدل الـ ventilation parameters.
- **Clinical picture**: clinical picture of the cause + effects of acidosis on different organs.

- **Treatment**:
  1. ABC
  2. Treatment of the cause * COPD → low flow oxygen.
  ± 3. Consider mechanical ventilation

Respiratory alkalosis

- ↑pH, ↓PCO_2 , ↓HCO_3^-
- **Causes**:

Central	Lung	Blood	Miscellaneous
Meningitis Hysterical Salicylates "early" Hemorrhage	Early pulmonary edema Minute pulmonary embolism Early pneumonia Pleurisy	Anemia Sepsis (early) Fever	Ascites Pregnancy Inadequate ventilation parameters

- **Clinical picture**: clinical picture of the cause + effects of alkalosis on different organs.
- **Treatment**:
  1. ABC
  2. Treatment of the cause
  ± 3. Consider mechanical ventilation

Interpretation of blood gases

11 Possibilities

1. High pH → alkalosis

+ High PCO_2 + High HCO_3^- → Simple metabolic alkalosis.
+ Normal PCO_2 + High HCO_3^- → Combined metabolic & respiratory alkalosis.
+ Low PCO_2 + Low HCO_3^- → Simple respiratory alkalosis.
+ Low PCO_2 + Normal or High HCO_3^- → Combined respiratory & metabolic alkalosis.

2. Low pH → acidosis

+ High PCO_2 + High HCO_3^- → Simple respiratory acidosis.
+ High PCO_2 + Normal or Low HCO_3^- → Combined respiratory & metabolic acidosis.
+ Normal PCO_2 + Low HCO_3^- → Combined metabolic & respiratory acidosis.
+ Low PCO_2 + Low HCO_3^- → Simple metabolic acidosis.

3. Normal pH

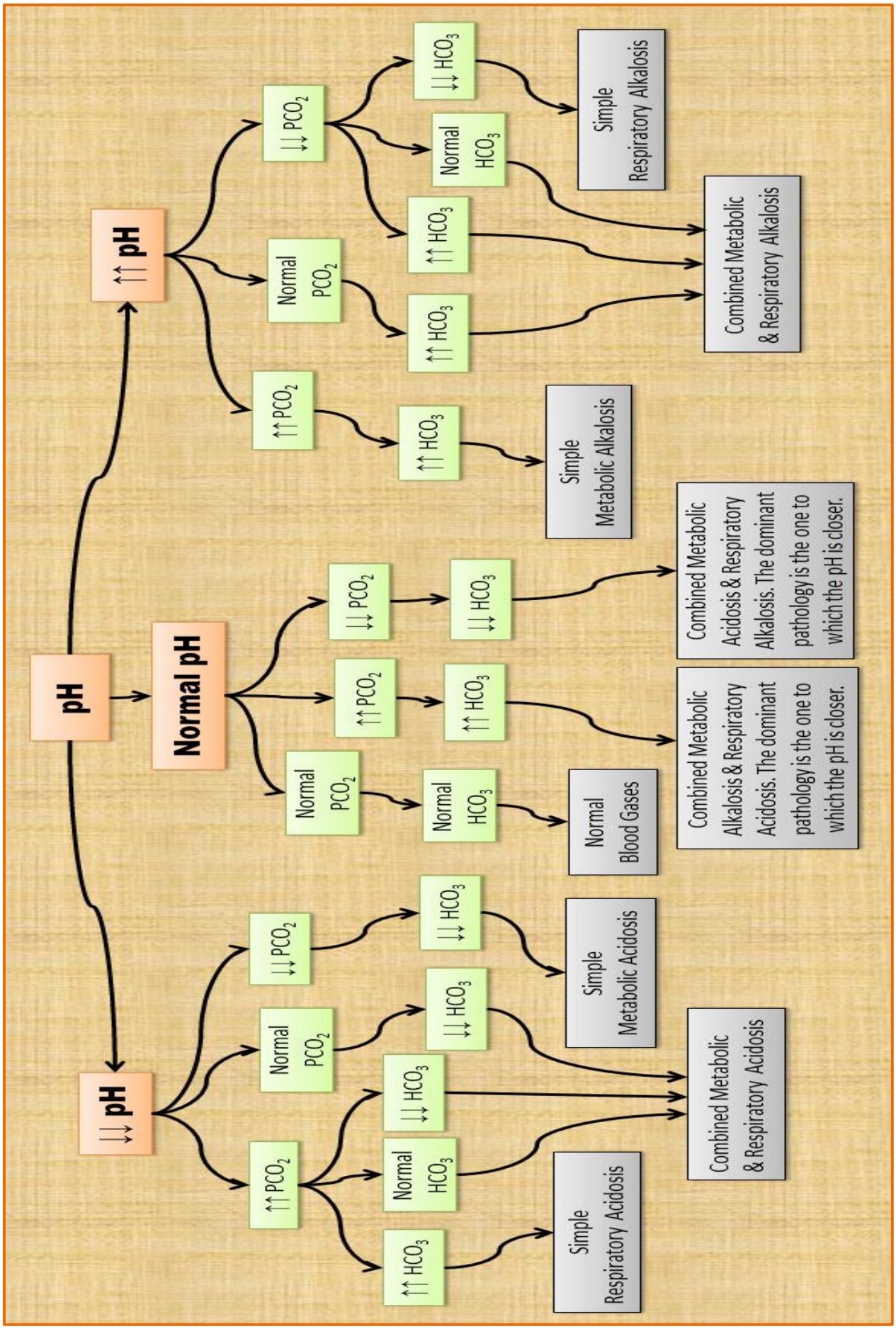
+ Normal PCO_2 + Normal HCO_3^- → Normal blood gases.
+ Low PCO_2 + Low HCO_3^- → Combined respiratory alkalosis & metabolic acidosis.

والـ dominant pathology هو اللي الـ pH أقرب ليه ...
يعني لو الـ pH كانت 7.36 يبقى الـ acidotic component هو الـ dominant .

+ High PCO_2 + High HCO_3^- → Combined respiratory acidosis & metabolic alkalosis.

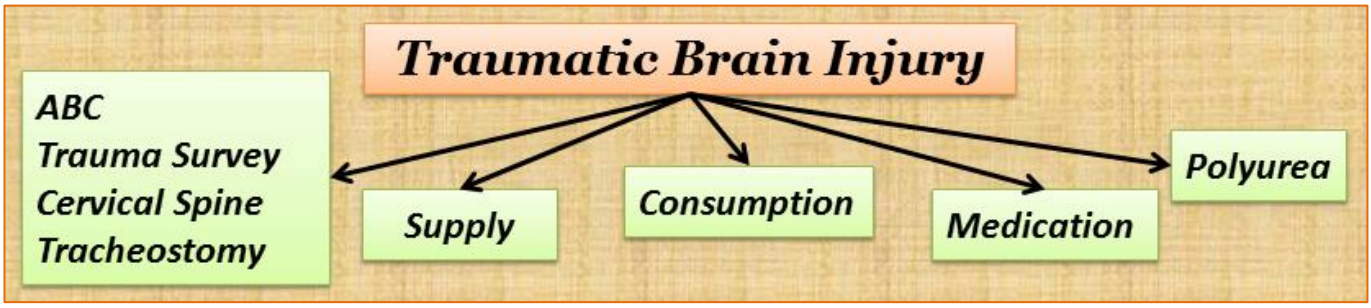
والـ dominant pathology هو اللي الـ pH أقرب ليه ...

Compensation does not completely correct the change in pH produced by the primary acid-base disorder.



TRAUMATIC BRAIN INJURY

✪ Any Trauma:
- ABC
- Trauma Survey
- Management of emergency (e.g. rupture spleen)



✪ Care of cervical spine:

1. The patient should be on a hard surface wearing a neck collar.
2. Cervical spine should be at the same level with the head & shoulders.

إزاي تنقل العيان؟ هدفك إن الـ shoulders, head & neck يتنقلوا فيا one unit إما على hard board أو إيديك الاثنين تحت اكتافه زي الجاروف وراسه مسنودة بالـ forearms عشان تضمن إن راسه في نفس مستوى اكتافه فترفعه one unit .

3. IV Solumedrol → 30 mg/kg over 1 hour,
   then 5 mg/kg/hr for 24 hours if started within 8 hours from the time of trauma.
   or 5 mg/kg/hr for 48 hours if started after 8 hours from the time of trauma.
   In case of complete avulsion of the cord → No role.

Goals (to avoid 2ry insult from ischemic penumbra)

1. ↓ Oxygen supply to the brain = ↑↑ CPP ***CPP = (MAP - ICP)***	***2. ↓ Oxygen consumption by the brain.***
1. MAP: Keep it > 65 mmHg … > 90 mmHg in hypertensive patients. N.B. Cerebral autoregulation: MAP 50-150. **2. Hemoglobin**: > 9 gm/dl. **3. Avoid hypoxemia:** Keep SO_2 > 90%. **4. Reduction of ICT:** see below.	**1. Anti-epileptics:** ♦ As convulsions ↑ O2 consumption by 300%. ♦ If no convulsions occurred→ Anti-epileptic for 1 week only. ♦ If convulsions occurred → Continue for 6 - 12 months. ♦ Infra-tentorial injuries or deep white matter injuries are not indications for anti-epileptics. بعيدة عن الموتور ♦ Any attacks of rigidty, tachycardia or hypoglycemia → consider sub-convulsive fits → Do EEG, CT or MRI with diffusion + Epanutin level. ♦ Status epilepticus → Start with maximum doses of dual anti-epileptic drugs + diprivan or dormicum infusion. Then do EEG → if controlled → stop infusion. If no EEG available → decrease dose gradually 20% by 20%. **2. Avoid fever:** As ↑ 1^oC → ↑ CMR by 7%. **3. Hypothermia:** Controversial

3. Medications

■ **PK Merz:** Used cautiously in case of recent convulsions or agitation as it may worsen them.
Dose: 5 mg/kg. Adjusted in renal patients.

■ **Melatonin:** Facilitates restoration of physiological rhythm النوم والصحيان & improves the conscious level.
Dose: 3-10 mg/kg/day. Can be increased up to 20 mg/kg/day in brain edema.
لكن عندنا بندي 3-10 mg/day .

☞ **Epanutin** interacts with procrolane & nimotop.

☞ **Levetiracetam (Tiratam or Keppra)** is available in IV form 500 mg.

☞ **Levetiracetam** tablets cannot be crushed.

☞ All **steroids** are containdicated in TBI. It may worsen the prognosis.

☞ **Maxipime & Tienam** increases convulsions.

♦ **Primary brain injury:** Occurs at the time of trauma & can't be treated الحتة اللي اتخبطت وماتت خلاص .

♦ **Secondary brain injury:** Ischemic brain injury that occurs after the initial trauma had occurred. hypoperfusion or لو حصل ischemia & inflammation المنطقة اللي حولين الحتة اللي ماتت (ممكن تموت نتيجة الـ hypoxia) ... هدفك إنك تمنع ال 2ry injury

■ ICP is formed by the brain (80%), CSF (8%) & Blood (12%).

■ ICP: 12-15 mmHg. N.B, IOP: 15-20 mmHg.

■ ↑↑ ICP → CSF displacement, then ↓CSF production, then brain herniation & finally conization → Cushing triad → hypertension, bradycardia &circadian rhythm.
يعني بتيجي في صورة attacks بتاخدلها ربع ساعة وبتفك عشان بيحصل drainage لشوية CSF فالضغط على الـ centers يقل فيفك وبعدين الـ tension يعلى تاني فيضغط على الـ centers تاني فيدخل في hypertension & bradycardia تاني وهكذا .

Signs of brain edema in CT: (in this exact order)
- Occluded basal cisterni.
- Obliterated sulci & gyri.
- Compressed ventricles

Status Epilepticus:
- Dual anticonvulsant maximum dose.
- Dormicum or diprivan infusion.
- If EEG calm for 48 hrs → stop infusion.
- If EEG not available → decrease dose gradually 20% by 20%.

Lens Adams Sydrome: Post-arrest convulsions.
Treatment: same as status epilepticus + Nootropil up to 9 gm plays a major role.

Methods to reduce ICP

1. Airway:
- Adequate pre-oxygenation & analgesia → fentanyl.
- Adequate muscle relaxation → sux or tracium, consider pre-curarization by 10 mg tracium. Give a muscle relaxant even if GCS < 8 to prevent cough reflex → to avoid ↑↑ ICT.
- Adequate hypnosis without affection of BP (only 50 mg diprivan).
- Xylocaine→ gel on tube, spray on vocal cords & IV… Use β-blocker & Magnesium.
- Don't give tridil as it ↑↑ ICT … Trimetaphan can be used to ↓↓ BP without ↑↑ of ICT.
- Avoid sympathomimetics, para-sympatholytics, katalar, hypoxia & hepercapnea.

2. Positioning:
- Head elevation 30^{o} - 45^{o} with central head positioning to allow drainage of IJV (3 fingers between angle of mandible & clavicle, 3 fingers between chin & suprasternal notch).
ليه 30^{o} ؟؟ لأن ده أحسن وضع يحصل فيه venous drainage كويس من غير ما الـ blood supply يقل .

3. Controlled Ventilation:

- Target → PO_2 > 60 mmHg, $SO_2 \geq 90\%$, PCO_2: 30-35 mmHg.
- To achieve hypocapnea→↑TV is more effective than ↑RR as alveolar ventilation = (TV-dead space) x RR.
- All inhalational anesthetics ↑↑ ICT by cerebral vasodilatation: Halothane by 200% → ↓by hyperventilation before introducing it... Isoflurane by 50% → ↓by concomitant hyperventilation.

4. Drugs:

- Mannitol:
  - ♦ Dose: 0.25 - 1 gm/kg …Onset: 15 min, maximum effect: 45 min, duration: 6 hrs. No benefit from increasing the dose > 1 gm/kg → ↑ duration of action without ↑ effect .
  - ♦ Mechanism of action: Osmotic diuretic, anti-oxidant (scavenger for oxygen free radicals) & initial hemodilution → ↓↓blood viscosity & ↓↓CSF synthesis.
  - ♦ Contraindications: Cardiac, renal (oliguria or anuria) & intracranial hemorrhage.
- Lasix: loop diuretic + ↓↓CSF synthesis + synergistic effect with mannitol.
- Precedex (Dexmedetomedine) & Aminophylline.
- Magnesium.
- Xylocaine infusion: 1-4 mg/minute.
- TIVA (propofol): بشرط الضغط يستحمل → 10 mg/kg in 1st 10 min, → 8 mg/kg in 2nd 10 min, → 6 mg/kg after that.

5. Electrolytes: Correct electrolytes especially after mannitol intake.

6. Fluids:

- ♦ Avoid hypotonic fluids as glucose containing solutions (glucose 5%) & half normal saline.
- ♦ Avoid hypervolemia.
- ☞ Ringer acetate & lactate are not hypotonic solutions.

7. Glucose: Avoid hypo & hyperglycemia ... Both are equally injurious.

8. Temperature: Avoid fever as every ↑1^{0}C above 37^{0}C → ↑↑ CMR by 7%.

9. Surgical intervention:

Intrathecal drainage (20-40 ml of CSF), decompression craniotomy or evacuation of hematoma if present.

- ☞ If GCS < 6 →→ Consider tracheostomy from day 4.
- ☞ Failure of conscious level to improve →→ Do EEG & MRI with diffusion & consider sub-convulsive fits.

الرنين هتعمله عشان توفر ع العيان لما يخرج من الرعاية مش أكتر

Polyurea in neurosurgical patient

- ♦ Keep an eye on Na^+ level.
- ♦ DD →→ Diabetes insipidus & Cerebral salt wasting.
- ♦ Target Na level in neurosurgical patient is 160.

Diabetes insipidus	*Cerebral salt wasting*
➢ ↑↑ serum Na^+ ➢ Give Minirin (desmopressin) tablets up to 4 tablets / 8 hrs … Or nasal spray → No nasal clots, kept in a refrigerator & the package is upright on administration. Sublingual tablets are also available.	➢ ↓↓ serum Na+ ➢ Give Astonin-H (fludrocortisone): 0.2 mg / 24 hrs. ➢ Investigations: 24 hr urine for osmolarity & Na level.

- Autoregualtion of all organs is MAP 50-150 mmHg except the kidneys → 80 - 180 mmHg.
  يعني ده range of MAP اللي الـ organ يقدر يتعامل معاه من غير ما يحصله damage ... يعني لو الضغط زاد في الرينج ده هيحصل vasoconstriction في الـ organ vessels فيقلل الدم اللي واصله وميحصلوش damage زي hemorrhage ... أو لو الضغط قل هيحصل فيه vasodilatation فيزود الدم اللي واصله وميحصلوش ischemia .
- Renal autoregulation depends on prostaglandins → Don't give NSAID in hypotensive anesthesia as it will interfere with renal autoregulation .
- Sedation of neurosurgical patient: Precedex, Haloperidol, Seroquel or Resperidal.

- Na correction in hyponatremia:
  - Na^+ deficit (mEq) = (130 - current Na) x TBW
  - Calculate the required volume according to Na concentration in used solution.
  - TBW in liters = 50% of body weight in females ... 60% of body weight in males.
  - Rate of correction: 0.5 - 1 mEq/hr to avoid central pontine demyelination → quadriplegia, pseudobulbar palsy, seizures, coma & even death.
    e.g, serum Na^+:110, Volume needed: 3,000 ml → Rate of correction= 75-150 ml/hr.
  - When to correct & what to use:
    - Manifested (i.e. DCL): use hypertonic saline.
    - Not manifested (i.e. conscious): use normal saline.

  - **Method of correction of Hypernatremia:**
    - Oral: Distilled water.
    - NPO: Recent neuro → Half normal saline.
      Not neuro → Glucose 5%.

	Extradural hemorrhage	***Subdural hemorrhage***
Source of bleeding	Arterial → Traumatic only. مش هيقف لوحده لأنه عشان يقف لازم الـ ICP يبقى أعلى من الـ MAP وده مبيحصلش.	Venous → Traumatic or spontaneous. ممكن يقف لوحده لو الـ ICP بقى أعلى من الـ venous pressure يعني أكبر من 15-20 mmHg
Prognosis after surgery	Conscious level usually improves لأن النزيف extradural مبيبقاش في فرصة لـ surgical brain injury	Conscious level usually deteriorates لأن النزيف subdural (منه للمخ) فممكن يحصل surgical brain injury
When to evacuate surgically	Must be evacuated even if not manifesting لأن النزيف arterial فمش هيقف لوحده .	♦ GCS: 6-9 > 9 → left for spontaneous absorption to avoid surgical complications. < 6 → Hopeless. ♦ Conscious level drop is due to significant SDH only > 1.5 cm.
		Glucose 5% can be given to ↑ICP → prevent hematoma expansion. Avoid mannitol if not evacuated → ↓ICP → hematoma expansion.

ISCHEMIC STROKE

Initial Management → ABC

a) Airway

- ♦ Indications of intubation: - Bulbar symptoms + pneumonia - GCS < 8
- ♦ Gradual initiation of feeding with **clear water** + **witnessed** to avoid aspiration.
  Consider semi-solids زبادي → better swallowed than liquids.

b) Breathing

- ♦ Assessment of ventilation.

c) Circulation

- ♦ BP 210/110 is accepted in the 1st 24 hours. لو العيان ماشي علي دوا ضغط وقفه
- ♦ BP 180/100 is accepted in the next 48 hours.
- ♦ If SBP < 100 → start levophed infusion.

☞ Target SBP in **Hemorrhagic stroke** → 150 mmHg with IV AGENTS IMMEDIATELY.

Further Management

If there is weakness in the 1st 4 hours:

- ★ Do urgent MRI with diffusion → If ischemic stroke → TPA.
- ★ If MRI is not available → Do CT brain to exclude hemorrhagic stroke, take a consent for hemorrhagic infarction & give TPA.
- ★ Assessment of conscious level every 4 hours.
- ★ In case of sudden deterioration of conscious level → Give mannitol + Lasix → Then CT brain:
  If there is midline shift → Consider decompressive craniotomy.
  بنتخانق عليها عشان تلحق العيان قبل ما يحصل conization .
- ★ Search for the cause after stabilization (ABC)
  Old patient: lipid profile, Echo & carotid duplex ...
  If carotid duplex is positive → Do CT cerebral angiography + vascular consultation.
  Young patient → Autoimmune profile,
  Protein C & S & anti-thrombin III after 3 months (↑ in acute phase).
- ★ PHYSIOTHERAPY + OUT OF BED → مهمين جدا في العيانين دول .

Medications

❶ Statins → Ator 80 mg or Crestor 40 mg.

❷ Aspocid 150 mg + Prophylactic anti-coagulant (clexane 40 mg SC/24 hrs).
or Aspocid 300 mg only.

☞ *In case of recurrent stroke → Aspocid + Plavix + Prophylactic anti-coagulation.*
☞ *If 1st time TIA → Aspocid, 2nd time→ Plavix, 3rd time → Aspocid + Plavix.*

❸ Anticoagulation: In patients indicated for therapeutic anti-coagulation (prosthetic valve, AF, DVT, etc) → Stop antiplatelet drugs & start **ORAL ANTICOAGULATION** as follows:
Minute infarction → After 3 days.
Moderate infarction → After 1 week.
Massive infarction → After 2 weeks.

- In patients with strong recommendation for therapeutic anticoagulation; e.g, recent pulmonary embolism, **PARENTERAL THERAPEUTIC** anti-coagulation can be started after 1,3,7 days according to the infarct size respectively, i.e, ½ duration before resuming oral anticoagulants.

- **PROPHYLACTIC** anti-coagulation can be started early especially in minute & moderate strokes.
- Heparin is better than clexane being short-acting with a specific antidote in case of development of hemorrhagic infarction on top of ischemic one.
- CT brain is indicated 24 & 72 hours after starting anti-coagulation to exclude development of hemorrhagic infarction.

- Brain stimulants have no role …
  Cerebrolysin is questionable + contraindicated in patients with renal impairment or convulsions.
- In hemorrhagic stroke or brain contusion → Prophylactic anticoagulation can be started after 4 days.

SHOCK

Clinical picture

1. Shock on admission. 2. Shock while in ICU. 3. ↑↑ dose of inotropes.

Differential diagnosis

1. HYPOVOLEMIC SHOCK →→ Excluded by static & dynamic measures.

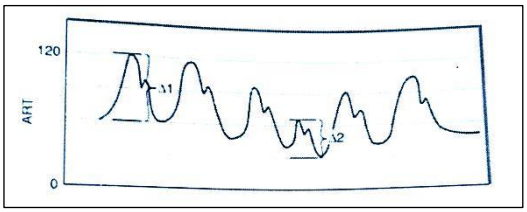
a) **Static measures:**

- ♦ CVP →→ Not accurate but the most available (the gold standard).
- ♦ Others →→ PAWP, RVEDV & LVEDV.

b) **Dynamic measures:**

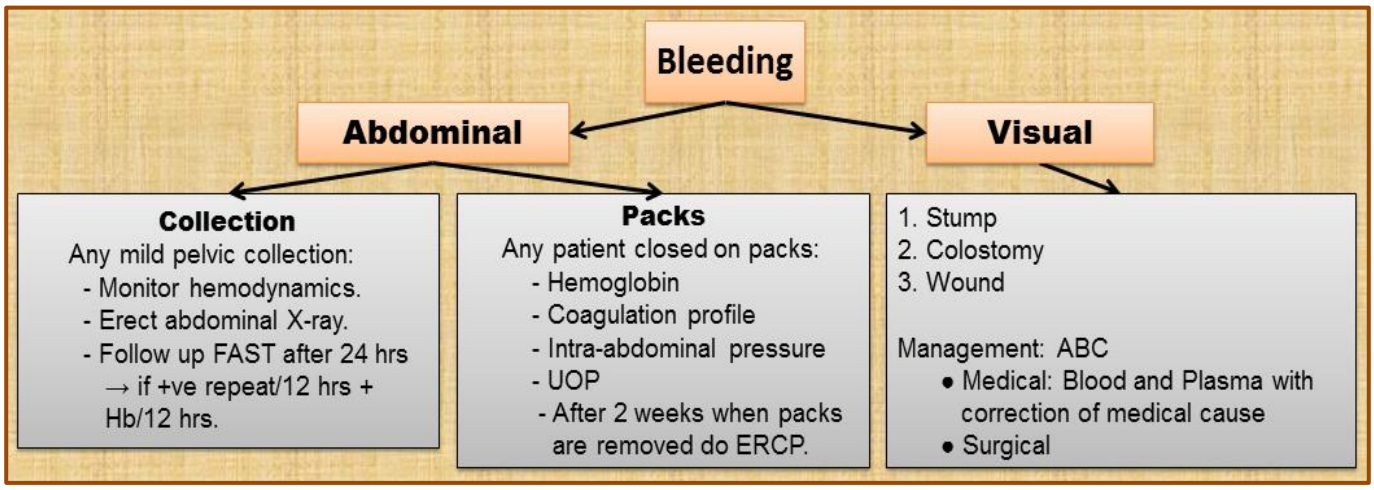
- ♦ Cardiometry →→ Mini-fluid challenge: 500 ml (150 -200 ml if hypoxic).
  or passive leg raising (مش بيتعمل دلوقتي)
  If > 10% increase in stroke volume → fluid responder …
  If < 10% → fluid non-responder.
- ♦ Echo →→ Kissing sign indicates hypovolemia.
  →→ IVC collapsibilty > 50% in spontaneously breathing patient
  or IVC distensibilty > 15 % in ventilated patient indicates hypovolemia.
- ♦ Pulse pressure variation (PPV) = $\frac{\Delta1-\Delta2}{(\frac{\Delta1+\Delta2}{2})}$ x 100

$\Delta1$ = max. systolic BP - max. diastolic BP
$\Delta2$ = min. systolic BP - min. diastolic BP
PPV > 13 indicates hypovolemia.
Criteria to perform PPV: Ventilated patient with TV > 8 ml/kg, relaxed with no arrhythmias.

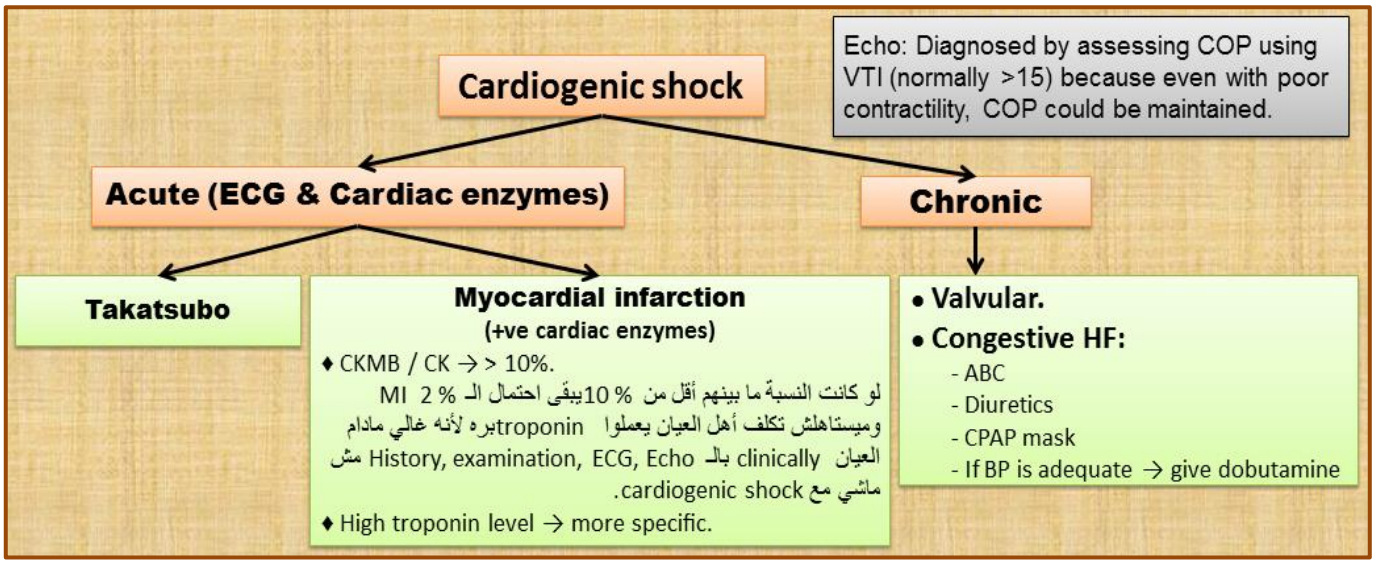


$$\frac{\Delta1 - \Delta2}{\frac{\Delta1 + \Delta2}{2}} \times 100\%$$

N.B. In case of wet lung (pulmonary congestion → P-lines in lung ultrasound) → Start inotropic support even if the patient is fluid responder.



2. CARDIOGENIC SHOCK



ECG Topography:

♦ Septal → V1,V2 ♦ Anterior → V3,V4
♦ Antero-septal → V1,V,V3,V4
♦ Lateral → I, aVL, V5, V6
♦ Antero-lateral → V3,V4, V5,V6, I, aVL
♦ Inferior → II, III, aVF.

3. OBSTRUCTIVE SHOCK

a) Pumonary embolism.
b) Pneumothorax: by Lung ultrasound or right side dilatation.
c) Cardiac tamponade: by Echo.

4. ENDOCRINAL SHOCK

♦ Diagnosis depends on history & hormonal profile.
♦ Myxedema & Addisonian crisis.
♦ Female, obese, bradycardic → Myxedema.
If myxedema give 300 µg of Eltroxin orally, If ryle → ↑dose by 25 µg.
♦ Addisonian Crisis: Hepatoadrenal, Pituitary, Adrenelectomy & Patient already on steroids.
Clinical picture: Metabolic acidosis, Hypovolemia, Hypoglycemia, Hyperkalemia & DCL.
Treatment: Solucortef IV 100 mg/8 hrs, saline & glucose infusion.

5. DISTRIBUTIVE SHOCK

a) Anaphylactic shock:

History of drug intake → Management: ABC + Adrenaline 0.5 mg IM.

b) Neurological shock:

♦ Central (cerebral) → Hemorrhage, trauma, tumor.
♦ Spinal cord (peripheral) → Trauma.

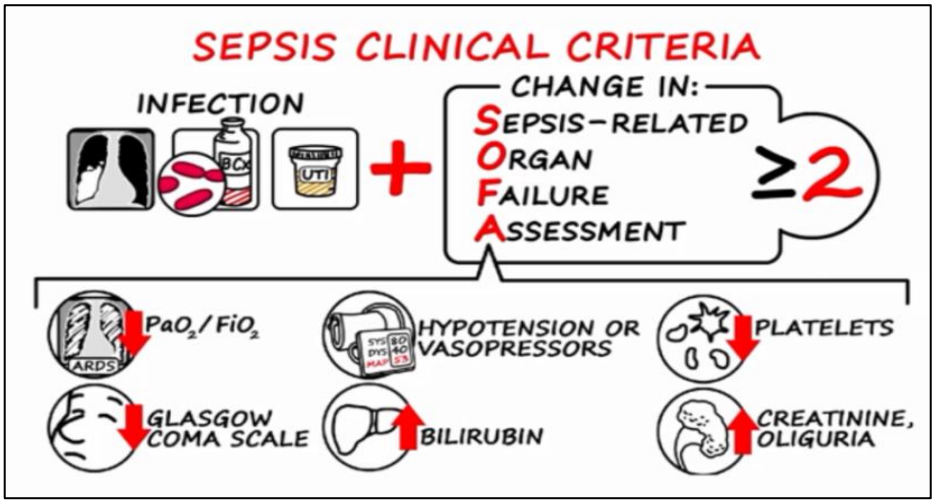
c) Septic shock: →→ Diagnosed by exclusion + presence of septic focus.

SEPSIS & SEPTIC SHOCK

Sepsis: *A life-threatening organ dysfunction caused by a dysregulated host response to infection.*

Organ dysfunction: *Acute change in total SOFA score ≥ 2 points consequent to the infection.*

Septic shock: *Sepsis with persisting hypotension requiring vasopressors to maintain MAP ≥ 65 mmHg & having a serum lactate level > 2 mmol/L (18 mg/dL) despite adequate volume resuscitation.*



Quick SOFA: **CNS: drowsy**

Chest: tachypnic (RR > 22)

CVS: borderline BP (systolic < 100)

If 2 +ve → ICU admission

Management of sepsis & septic shock

➢➢ Supportive treatment (ABC) :

العيان يكون ماسك ضغط و saturation خلال نص ساعة يا إما يوصل max max

- ♣ Airway protection: Supplemental oxygen ± intubation بنتلكك عشان نحطله أنبوبة .
- ♣ Breathing: Ventilator parameters as ARDS & follow up by ABG.
- ♣ Circulation: Maintain MAP > 65 mmHg (> 80 if hypertensive) to ensure adequate perfusion.

ـ امسك الضغط الأول بـ vasopressors وبعدين شوف الـ fluid responsiveness وانزل بالـ vasopressors بعد كده براحتك

Signs of hypoperfusion include:

CNS: DCL.

CVS: Tachycardia, hypotension, weak thready pulse & delayed capillary refill > 2 sec.

Respiratory: Tachypnea. Renal: Oliguria. Others: ↑Lactate & Cold clammy skin.

➢➢ Definitive treatment:

1. Pan-cultures

2. Elimination of Septic focus:

- **Medical:** Broad spectrum antibiotics → تتحل وتتاخد وانت واقف بتستلم العيان

  In cases with very low TLC count → consider IVIG

  If neutrophils < 500 → Neupogen
- **Surgical**

3. Follow up lactate level (lactate clearance):

After 6 hours → lactate should ↓↓ > 10% … Target: < 2 mmol/L.

4. Fluid resuscitation

- According to fluid responsiveness (static & dynamic).
- Target CVP: 8 mmHg (12 cmH_2O) in spontaneously breathing patient and 12 mmHg (15 cmH_2O) in ventilated patient.
- Crystalloids are preferred.
- Avoid colloids as it may worsen the prognosis.
- Albumin 5% can be used (after 30 ml/kg crystalloids & the patient is still responder).
  بنحط 2 فيال من البيومين 20% (كل فيال 50 سم) على 400 سم رينجر .
- Avoid fluid overload as it may worsen ARDS.
- Stop fluid resuscitation if the patient become stable, non-responder or congested clinically (hypoxic) or radiologically (P-lines in lung ultrasound)… If so & still fluid responder → consider inotropic support.

5. Mean ABP:

- Keep MAP > 65 mmHg (> 80 if hypertensive) → Start with Nor-adrenaline then Adrenaline.
- If the rate of nor-adrenaline infusion > 6 ml/hr → Add Solucortef 50 mg/6 hrs IV plus Astonine-H (fludrocortisone) 0.1 mg oral tablet/24 hrs.
- In pediatrics: Warm septic shock: start with dopamine → then levo → then adrenaline.
  Cold septic shock: start with dopamine → then adrenaline → then levo.

6. Central venous saturation ($ScvO_2$):

- Keep it > 65 %.
- If < 65% → improve oxygen carrying capacity by ↑↑ Hb > 9.
- If still < 65% → start dobutamine infusion in adults (لو ضغطه يسمح) or adrenaline in pediatrics.

حاليا اتشالت من الحاجات اللي بنتابعها في الـ septic shock لكن ناس كتير مقتنعة إنها مهمة وهترجع تاني.

7. UOP: Keep it > 0.5 ml/kg/hr & Confirm adequate **Peripheral perfusion.**

- Mixed venous saturation (SvO_2): obtained from pulmonary artery catheter & represents the function of oxygen delivery & extraction in the entire body. Normal value 70-75%.
- Central venous saturation ($ScvO_2$): obtained from CVL (superior vena cava) & indicates oxygen consumption from the upper half of the body including the brain → So, it is slightly less than SvO_2 (about 5). However, in anesthesized patient it increases due to decreased cerebral metabolic rate.

BURN

Burn assessment

❶ **Percentage.**

❷ **Degree:** 1st → Epithelium 2nd → Dermis 3rd → Full skin thickness

❸ **Type & Site:**

- Eye → watch out for corneal ulcers
  → Ophthalmology consultation
- Airway → consider intubation (48 hrs ??) & antiedematous measures
- Lungs → ARDS (consider CO toxicity)

❹ **Parkland's formula**: 4 ml/kg/% of burn → maximum 50% burn.

- If hypoxic → 3 ml/kg/% of burn.
- If severely hypoxic → 2 ml/kg/% of burn.

❺ **CK, CKMB** → to check up on risk of AKI, with risk being high if CK > 5000.

❻ **GIT & feeding:**

- ASAP (start oral)
- Adequate caloric intake (high protein & high caloric intake)
- Central abdominal pressure in circumferential burns
  If more than 20 cmH_2O :
  1. Ryle
  2. Prokinetics
  3. Release of muscles (if acidotic or oliguric with increased intraabdominal pressure)

❼ **Pain & Psychosis:**

- Gaptin
- Tryptizole
- Seroquel

❽ **Medical:**

- Cultures
- Antibiotics with sepsis markers
- IVIG in pediatrics → keep an eye on CNS, CVS & respiratory

❾ **Surgical:**

- Early debridement (after proper preparation → Hb, platelets, INR)

❿ **Physiotherapy & Out of Bed.**

Indications of ICU admission

1. Smoke inhalation for fear of airway obstruction.
2. 2nd degree burn involving > 25% of body surface area.
3. 3rd degree burn involving > 10% of body surface area.
4. Development of complications as sepsis, hypothermia & multi-organ failure.

Medical considerations of burn patients

a) <u>Airway considerations:</u>

- Recent burn:
  - Face mask → painful & difficult.
  - Endotracheal tube → difficult insertion & fixation.

    Indications of intubation of burn patient:

    Hypoxia, upper airway edema that may progress to obstruction & presence of copious secretions.

    Awake fiberoptic may be needed.

    Take care of full stomach.
- Old burn: Suspect greater difficulty.

b) <u>Respiratory considerations:</u>

- Inhalational injury:
  - Upper airway edema → obstruction.
  - Lower airway direct thermal insult → ARDS.
- Carbon mono-oxide inhalation:
  - Shift of oxy-hemoglobin dissociation cure to the left.
  - Diagnosed by co-oximeter (>15% Carboxy-hemoglobin in the blood).
  - Normal PO_2, skin color and pulse oximeter reading.
  - Affinity of CO for Hemoglobin is 210 times that of oxygen.
  - Reduces oxygen-carrying capacity.
  - CO-Hb level > 20 - 40% are associated with neurological impairment, fatigue, disorientation & shock.
  - Half life of CO is 2 - 4 hours.
  - Half life is one hour with 100% O_2.
  - Half life is 15 minutes with hyperbaric O_2 (take care of convulsions).

☞ **So**: Secure the airway by intubation, 100% oxygen, humidification of gases & suctioning. Bronchodilators are essential in patients with major burn.

c) <u>Cardiovascular considerations:</u>

- Intravascular volume depletion:
  - Parkland formula: Lactated Ringer's infusion: 4 ml/kg/ % of involved area in the 1^{st} 24 hrs. The 1^{st} ½ in the first 8 hours & the 2^{nd} ½ in the next 16 hours.
  - Fluid therapy should be monitored by urine output (1 ml/kg/hr), blood pressure, static measures (CVP) or dynamic measures (cardiometry).
  - Blood, colloids or albumin transfusion may be indicated.
  - Inotropic support may be beneficial.
  - Early excision + grafting is associated with major blood loss.

d) <u>Electrolytes & acid base disturbance:</u> Follow up & correct.

e) <u>Hypothermia:</u> due to loss of skin.

- Exaggerated by the effects of vasodilatation & large amounts of IV fluids. So, the patient should be warmed.
- Minimized by using warming blankets and heat lamps, Ambient temperature, humidifying the inspired gases and warming the IV fluids.

Normothermia for burn patient is approximately 38.5°c due to resetting of the centrally mediated thermostat.

f) Immune & septic complications: Antibiotics & disinfection strategies.

g) Problems related to artificial nutation: See nutrition.

h) Pharmacology of anesthetic drugs.

- Sux → allowed in the first 24 hours then contraindicated up to 6 months.
- Non depolarizing muscle relaxants → higher doses are required due to resistance.
- Volatile anesthetics → exacerbate myocardial depression.
  Halothane should be avoided if adrenaline-soaked bandages are used due to higher incidence of arrhythmia.

Treatment

1. Antibiotics: See soft tissue infection.

2. Analgesic antipyretic → Perfalgan 1 gm/ 8 hrs + morphine 5 mg/8hrs.

3. Anticoagulant → Clexane 40 mg SC/24 hrs.

4. Antacid: Losec

40 mg/24hrs for prophylaxis against Curling ulcer (stress ulcer of the duodenum).
- Without antacid prophylaxis → the incidence is high.
- Early enteral feeding plays a great role in prophylaxis .

5. ABC:

- Airway: Secure the airway by ETT, 100% O_2, humidification of gases, suctioning & bronchodilators. Daily CXR if there is risk of inhalational injury (ARDS).
- Breathing → Assessment of breathing.
- Circulation → Fluid resuscitation (Parkland formula).
  Lactated Ringer's infusion: 4 ml/kg/ % of involved area in the 1st 24 hrs.
  The 1st ½ in the first 8 hours & the 2nd ½ in the next 16 hours.
  + 30 ml/kg/day maintenance.
  Monitored by: UOP > 0.5 ml/kg/hr, MAP > 65 mmHg, static & dynamic measures.

6. IVIG: Indication: Toxic shock syndrome.
Mechanism of action: Neutralization of circulating toxins.
Dose: 100-400 mg/kg.
Precautions before administration: Hydration with 10 ml/kg saline + anti-histaminic + steroid in case of previous anaphylaxis to IVIG.

7. Alpha-chemotrypsin: once or twice daily (IM only) .... **Alphintern** 1-2 tab/8 hrs.

8. Cevarol & Becozyme 1 ampoule IV/24 hrs.

9. Mebo, Bivatracin & Dermazine دهان ورش كل 8 ساعات .

10. Take care of Rhabdomyolysis: Follow up CK & CKMB.

11. Insert CVL & Urinary catheter.

12. Invasive BP monitoring: Indicated in the following conditions:
- Difficulty with non-invasive.
- Inotropic support.
- Fluid status assessment using PPV.

13. **<u>Early excision & grafting:</u>** play a great role in improving the outcome.
14. **<u>Gut decontamination ??</u>**
    - Amikin 15 mg/kg/dose (Oral)
    - Vancomycin 15 mg/kg/dose or 50 mg/kg/day (Oral)

ANTIBIOTICS

Classification of antibacterial agents

Antibiotics that target the cell wall	Antibiotics that block protein production	Antibiotics that target DNA and replication
➢ β-Lactam Antibiotics ➢ Glycopeptides ➢ Colistin	➢ Macrolides ➢ Aminoglycosides ➢ Clindamycin ➢ Tigecycline (Tygacil) ➢ Linezolide (Zyvox)	➢ Quinolones ➢ Metronidazole ➢ Sulphonamides.

Antibiotics that target the cell wall

➢ **β-Lactam Antibiotics**: Bactericidals

★ **Penicillins**:

♦ Naturally occurring penicillins. Active against gram +ve e.g. penicillin G.

♦ Anti-staphylococcal penicillins with extended spectrum against gram +ve e.g. Methicillin.

♦ Amino-penicillin with activity against gram –ve e.g. Ampicillin

♦ Extended spectrum penicillins: Active against gram -ve & pseudomonas e.g. Piperacillin.

✍ Penicillins with β-Lactamase inhibitors:

- Ampicillin-sulbactam → Unasyn / Unictam
- Amoxicillin-clavulanate → Augmentin
- Piperacillin-tazobactam → Tazocin

★ **Cephalosporins**

♦ First generation → Effective against gram +ve e.g. Cephazolin.

♦ Second generation → Extended activity against some gram –ve e.g. Cefotetan.

♦ Third generation → More effective against gram –ve e.g Ceftazidime (Fortum).

♦ Fourth generation → Has good gram +ve and gram –ve e.g. Cefipime (Maxipime).

♦ Fifth generation → Has expanded the activity against gram +ve to include MRSA e.g Ceftaroline

★ **Carbapenems**

♦ Imipenem-cilastatin (Tienam) → active against gram +ve, gram –ve and anerobic bacteria

♦ Meopenem (Meronem).

♦ Doripenem.

♦ Ertapenem (Invanz) → Does not cover pseudomonas → Not used in chest infection.

★ **Monobactam:** Aztreonam, gram –ve only, not used.

➢ **Glycopeptides:**

- Spectrum: Gram +ve & staph.

♦ Vancomycin:

- The most effective anti-staph.
- Nephrotoxic + Red man syndrome if > 50 mg/min (histamine release → VD → redness of upper half of the body → TTT: hydration + anti-inflammatory. Avoided by infusion over 1 hour.

♦ Teicoplanin (Targocid)

- less nephrotoxic
- Dose: Loading 400 mg/12 hrs for 3 doses then 400 mg/day.

➢ **Colistin**

- Belongs to polymyxin group of antibiotics.
- Spectrum: Gram – ve only.
- Better to be used with another agent: sulperazone/unasyn or zyvox/vanco/targocid.
- Can be given by inhalation in cystic fibrosis or lung abscess.
- Severely Nephrotoxic → adjusted in renal impairment.
- Dose: Adults: Loading: 9 million units → Maintenance: 4.5 million units/12 hrs.
  Pediatrics: 2.5 - 5 mg/kg/day divided into 3 doses (No loading dose).

كل مجم فيه 34 وحدة ... اضرب الجرعة في 34 عشان تطلعها بالـ units .

Antibiotics that block protein production

➢ **Macrolides:**

- Erythromycin, Clarithromycin, Azithromycin
- Spectrum: Gram +ve & atypical bacteria → Used in community acquired pneumonia.

➢ **Aminoglycosides**

- Spectrum: Gram -ve & staph.
- Nephrotoxic & ototoxic.
- Can be given by inhalation.

➢ **Clindamycin (Dalacin)**

- Spectrum: Gram +ve & anaerobes → Used in soft tissue infections.
- ✋ Adverse effects: Psuedo-membranous colitis → treated by flagyl.

➢ **Linezolide (Zyvox):**

- Spectrum: Gram +ve & staph.
- High bioavailability (easy to switch to oral therapy).
- Used safely without adjustment in renal failure.
- Photosensitive (special cover) + large volume (600 ml/day).
- Adverse effects: Lactic acidosis, thrombocytopenia (after 10-14 days).

➢ **Tigecycline (Tygacil)**

- Spectrum: Gram +ve, staph, anaerobes & gram -ve but not pseudomonas & proteus.
- Used in soft tissue & abdominal infections.
- Concentrated in soft tissues & abdomen.
- Does not maintain adequate blood level → Not used alone in septicemia.
- Not good in chest infection (pseudomonas).
- Used safely without adjustment in renal failure.
- Dose: Loading 100 mg once then 50 mg/12 hrs .. in chest infection 200 once → 100/12hrs.

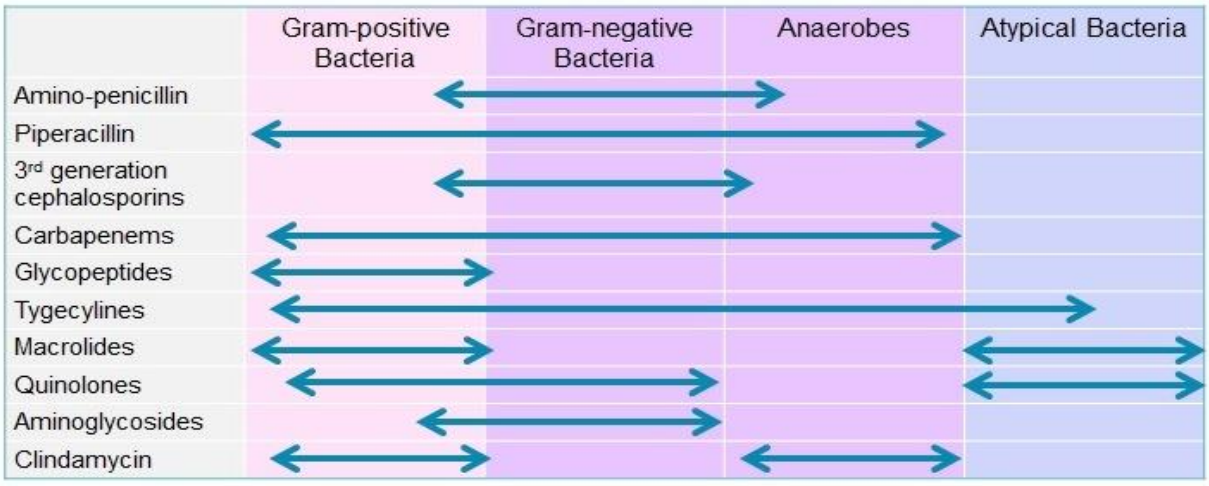
Antibiotics that target DNA and replication

➢ **Quinolones**

- Ciprofloxacin (Cipro) & Levofloxacin (Tavanic).
- Spectrum: Gram -ve, atypical & some gram +ve.
- Adverse effects:
  Pediatrics: Immature closure of epiphysis, so contraindicated in children below 18 years but can be used for 1 week.
  Geriatrics: DCL.
  Prolonged QT interval & predispose to ventricular arrhythmias.

➢ **Metronidazole (Flagyl)**

➢ **Sulfonamides**



Infections in ICU:

1. **Pneumonia: Hospital-acquired & community-acquired.**
2. **Peritonitis: Primary & secondary.**
3. **Soft tissue infections: as Necrotizing fasciitis & forneir gangrene.**
4. **Diabetic foot.**
5. **Infective endocarditis.**
6. **FB in the eye.**

1. Chest infection

➢ **Diagnosis of pneumonia**

1. Radiological finding.

± 2. Fever / productive cough / hypoxia / aspiration / culture.

1. Hospital acquired pneumonia and ventilator-acquired pneumonia

➢ Organism: Usually gram negative.

➢ Use dual anti-pseudomonal drugs:

Tienam / Meronem / Maxipime

\+ Aminoglycoside / Quinolone

piperacillin-tazobactam 4.5 g IV/6hr OR

Imipenem 500 mg IV q 6h OR

Meropenem 1 g IV q 8r OR

plus

Vancomycin 15 mg/kg IV q12h or linezolide 600 mg IV/PO q12h

plus

Aminoglycoside (gentamycin 7 mg/kg/day IV or Amikacin 15 mg/kg/day IV) OR

Ciprofloxacin 400 mg IV q8h

➢ If the incidence of MRSA > 10% → add anti-staph: Vanco / Targocid / Zyvox.

2. Community-acquired pneumonia

➢ Organism: Strept. pneumonia, H. influenza & Atypical organisms.

➢ No risk of pseudomonas: Tavanic / Augmentin / Rocefin / Maxipime ± Klacid / Zithromax severe cases.

➢ Risk of pseudomonas or hemodynamically unstable: as hospital acquired pneumonia (without anti-staph).

Risk of pseudomonas

Alcoholism

Chronic bronchiasis

Mechanical ventilation

Febrile neutropenia

Septic shock with organ failure

N.B, In chest infections, focus on anti-pseudomonal & don't rush to anti-gram +ve.

2. Abdominal infection

Primary peritonitis: عيان بطنه اتفتحت مرة واحدة

☜ لو عيان كويس وماسك نفسه ← 3rd or 4th generation Cephalosporin + Flagyl

☜ لو عيان متكحول ملوش غير فرصة واحدة بمعني :

Hemodynamically unstabe, prolonged hospital stay, immunosuppressed, on steroids

في الحالات دي بنبدأ من الأول بواحد من العائلات الكبيرة من الـ antibiotics اللي هي Tienam, Meronem, Invanz, Tazocin

Secondary Peritonitis: عيان بطنه اتفتحت أكثر من مرة →→ ± antifungal ± antistaph.

☞ **Indicators of improvement or deterioration:**

1. Fever 2. Lactate 3. TLC 4. CRP 5. Dose of vasopressor

☜ لو العيان لسه مطلعلوش مزارع ومش بيتحسن ننزل بسهمين Medical & Surgical

Surgical → كلم الكبير يكلم الكبير

Surgical sources of sepsis:

♦ Chest: Abscess, empyema, pneumonia with complete obstruction (for bronchoscopy).
♦ Abdomen: leakage (collection).
♦ Soft tissue: diabetic foot for debridement or amputation, pockets of pus, vaccum.

Medical

♦ قبل ما تنقل من كل step للي بعدها لازم تراجع السهم الـ surgical وتتأكد إنه controlled الأول .

➢ لو انت بادئ بالجروب الاول انقل علي جروب التينام أو اخواته.

➢ لو انت بادئ بالتينام و اخواته هتزود الآتي:

Add extreme anti-gram +ve (MRSA) especially in case of burn, soft tissue or abdominal infection as vancomycin, targocid or zyvox.

➢ لو مفيش تحسن بعد 48 ساعة:

Add antifungal: Diflucan (in stable patients or can't afford)
or V-fend (voriconazole) if unstable patients or if diflucan is endemic.
or Amphtericin B: The gold standard of anti-fungal drugs
Conventional form → Fungizone (nephrotoxic, hepatotoxic, ↓K) → cheap 125 LE.
& Liposomal form → Ampisome (no adverse effects) → expensive 1820 LE !!
or Echinocandins → Mycamine, Ecalta, Caspofungin → very expensive.

➢ لو مفيش تحسن بعد 48 ساعة: Extreme gram -ve

Hopeful	**Hopeless**
- Can afford: Add extreme gram -ve (Acinetobacter, E.coli, Pseudomonas, Proteus) as [Colistin + (Sulperazone or Unasyn)] . **- Can't afford:** Available donations → Colistin. No available donations → Tygacil. Tygacil: Not strong in severe sepsis, against pseudomonas & in chest infection, so double the dose In Chest Infections: Consider Amikin nebulizer 400 mg/12 hrs	**- Can't afford:** يكمل على اللي ماشي عليه وخلاص **- Can afford:** لو عايزينه معاهم يشتروا Colistin . لو عايزينه يترحم يكمل على اللي ماشي عليه .

➢ لو مفيش تحسن بعد 48 ساعة ←← **Consider viral** (tamiflu in pneumonia cases) **or TB infection**

☜ لو العيان طلعله مزرعة

1. لو العيان بيتحسن والمزرعة طلعت resistant للمضاد الحيوي اللي ماشي عليه و sensitive لمضاد حيوي تاني يبقي ننفض للمزرعة .
2. لو العيان مش بيتحسن والمزرعة طلعت مضادات حيوية غير اللي أنا كاتبها يبقي تمشي مع المزرعة وبرده تتأكد من السهم الـ surgical .
3. لو العيان بيتحسن علي المضادات اللي انا كاتبها والمزرعة طلعت sensitive لواحد منهم تحديداً يبقي نكمل علي اللي طلع في المزرعة و نوقف الباقي (de-escalation) .
4. لو العيان مش بيتحسن والمزرعة طلعت sensitive لنفس المضادات اللي ماشي عليها يبقي ننفضلها ونرجع للـ algorithm .

3. Soft tissue infection

- Stable: 3rd or 4th generation + Anti-staph + Dalacin
- Unstable: Invanz/ Tienam/ Meronem/ Tazocin + Anti-staph + Dalacin.

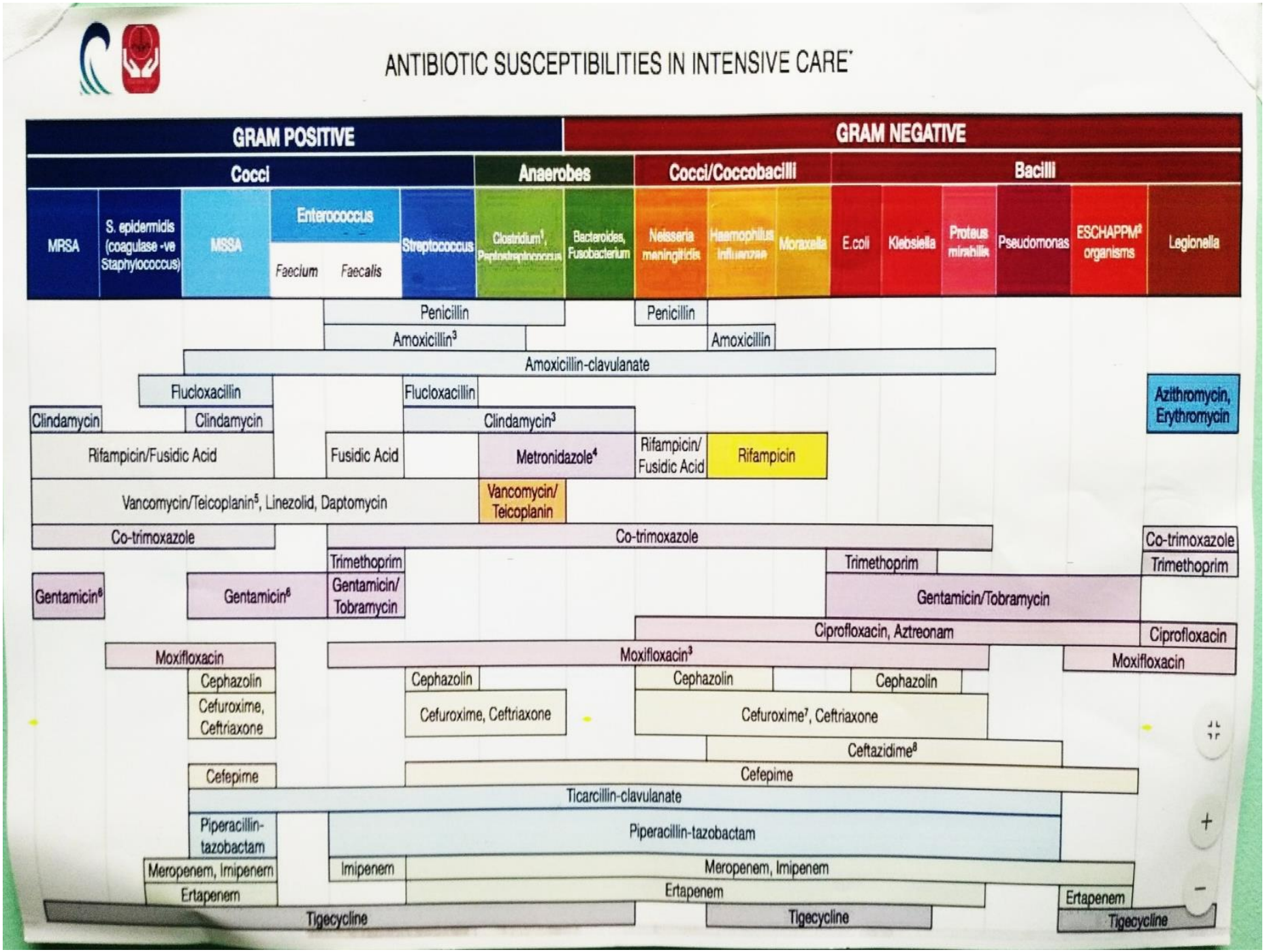
4. Diabetic Foot:

- **Stable:** 3rd or 4th generation + Dalacin
- **Unstable:** → start with Invanz/ Tienam/ Meronem/ Tazocin + Dalacin.
-

5. Infective Endocarditis

6. IntraOcular: → Vancomycin.

- Skull depressed fracture → Vancomycin + 3rd generation cephalosporin.
- Anti-staph antibiotics: Vancomycin, Targocid, Zyvox
- Antibiotics act by either:
  - ♦ Peak serum level: given once daily as aminoglycosides.
  - ♦ Steady serum level: multiple doses.
- Extreme gram +ve: MRSA
- Extreme gram -ve: MDR → Pseudomonas, Klebsiella, Acinetobacter, E.coli



MYOCARDIAL INFARCTION

Clinical picture

Ischemic patient with acute attack of typical chest pain → Angina or MI.

Diagnosis

Angina: Typical chest pain + ECG changes.

MI: ↑↑ Cardiac enzymes + ECG changes and/or Typical chest pain.

Management

➢ **STEMI:** Immediate catheterization + Streptokinase.

If not available or streptokinase is absolutely contraindicated → Manage as NSTEMI.

➢ **NSTEMI:**

1. ***ABC:***

- Volume, BP, Perfusion & Hb (target is 9-10 or hematocrit 27-30)

2. ***MONA:***

♦ **Morphine**: the drug of choice for analgesia + venodilator → ↓ preload.

♦ **Oxygen supplementation**: If SO_2 < 90% ... Avoid hyperoxia → ↑ mortality.

♦ **Nitrates**: Provided that BP is stable.

- Nitroderm patch: Not preferred due to its unpredictable absorption + residual absorption after removal.
- Sublingual tablets: 3 times with 5 minutes interval (1 tab = 2.5 mg).
- Tridil infusion: Considered in HF.
  Monitor BP.
  Once stopped → the effect stops due to the very rapid metabolism of nitroglycerin (1 minute).
  Contraindicated in Hypotension or right ventricle infraction, severe AS, HOCM & PE.

♦ **Anti-platelets**: Stopped if platelet count < 50,000

- Aspirin: 300 mg loading then 150 mg/day.
  If contraindicated → Agrastat I.
  In DU → Aspirin protect.
- Plavix: 300 mg loading then 75 mg/day.
  or Berlique → Side Effects:
  Poor compliance (1 tab/ 12 hrs).
  Dyspnea in 15-30% of patients.

N.B. If you shift from Berlique to Plavix → reload Plavix

♦ **Anti-coagulant**:

Stable: Clexane: 1 IU/kg/12 hrs (therapeutic dose) according to actual body weight.

Unstable or ↑↑ creatinine: Heparin IV infusion (60 IU/kg IV bolus then 12 IU/kg/hr) →
Target PTT 40 - 70 ... If not available → ½ clexane dose.
If no available syringe pump → IV Heparin 5,000 IU/ 4-6 hrs.

🗐 Heparin dose in pulmonary embolism: 80 IU/kg IV bolus then 18 IU/kg/hr.

Patients with low platelet count: Arixtra → (therapeutic dose in MI is 2.5 mg/24 hrs because origin of the clot is arterial), its set back is prolonged half life (needs to stop 36 hrs before regional and 3 days before surgical incision)

Table 6.5 Weight-Based Heparin Dosing Regimen

1. Give initial bolus dose of 80 IU/kg and follow with continuous infusion of 18 IU/kg/hr. (Use actual body weight.)
2. Check PTT 6 hrs. after start of infusion, and adjust heparin dose as indicated below.

PTT (sec)	PTT Ratio	Bolus Dose	Continuous Infusion
<35	<1.2	80 IU/kg	Increase by 4 IU/kg/hr
35–45	1.3–1.5	40 IU/kg	Increase by 2 IU/kg/hr
46–70	1.5–2.3	—	—
71–90	2.3–3.0	—	Decrease by 2 IU/kg/hr
>90	>3	—	Stop infusion for 1 hr. then decrease by 3 IU/kg/hr

3. Check PTT 6 hrs. after each dose adjustment. When in the desired range (46–70 sec), monitor daily.

3. ***Statins:***

- Recommended for all patients with MI, irrespective of cholesterol concentration.
- Higher-intensity statin therapy : Atorvastatin (ator) 80 mg/day
  or Rosuvastatin (crestor) 40 mg /day.
- Lower-intensity statin therapy : Simvastatin (zocor) 10 mg/day, used when side effects develop from higher intensity statins in high risk patients.

  Ator → considered in renal patients.

  Crestor → considered in cirrhotic patients with normal enzymes up to 1.5 fold increase & in rhabdomyolysis

  If liver enzymes ↑ → give half dose.

  If liver enzymes still ↑ → give Zocor.
- Side effects: muscle pain & weakness, could be severe.

Any diabetic patient aged > 40 years should be maintained on statin therapy even if not ischemic.

4. ***Rate control:***

♦ Concor:

- In hemodynamically stable patient.
- Target HR: 50-60 bpm or below the trigger in stress ECG.
- Contraindications: Acute heart failure, Cardiogenic shock, First degree HB & Obstructive pulmonary disease.

♦ Procorolan:

- Dose: 5 - 7.5 mg/ 12 hrs.
- Given instead of concor in patients with borderline BP.
- Blocks Na-K channels in SA node (funny channels) .
- Contraindicated in patients with arrhythmias.

♦ Lanoxin:

- If concor & procorolan are contraindicated.
- Used with caution in renal patients (adjusted dose & frequent digoxin level).
- Works in bed-ridden patients, otherwise will not control HR on its own.

5. Prevention of remodelling:

♦ ACEIs (capoten or tritace) → keep an eye on kidney, BP & K.

♦ ARBs (take care of BP)

With ACEIs & ARBs → if creatinine rise is not more than 50% from baseline → continue ttt .

♦ Chlorothiazides & Aldactone (contractility < 30%)

Side effects of aldactone include: gynecomastia

♦ Aldosterone receptor antagonists (eplerenone): Alternative to Aldactone..

Recommended in patients with an LVEF ≤ 30%, heart failure or diabetes. They had been shown to reduce morbidity and mortality in these patients.

6. Angiography& revascularization (PCI or CABG):

- Immediate within 2 hours: Malignant ventricular arrhythmias, Hemodynamic instability, HF & Severe chest pain despite adequate anti-ischemic & analgesic measures.
- Early angiography (24 hours): High troponin or ST elevation not meeting STEMI criteria.
- Angiography (24- 72 hours): Recurrent angina or EF < 40%, diabetes & renal insufficiency.

- The most important 2 drugs in CPR → Oxygen & Adrenaline.
- During CPR → IV access through femoral (Blind insertion) arterial or venous.
- To perform coronary angiography → The HR should be around 60 .
- Dual anti-platelet therapy for:

  Balloon angioplasty → 3 weeks

  Metal stent → 6 weeks to 3 months

  Drug eluting stent → 1 year.

☞ In this time frame, if a patient requires emergency surgery:

Stop Plavix → give aspocid + NOACs.

Stop NOACs just before operation then resume Plavix after operation.

Provided being in a place with 24 hr catheterization available.

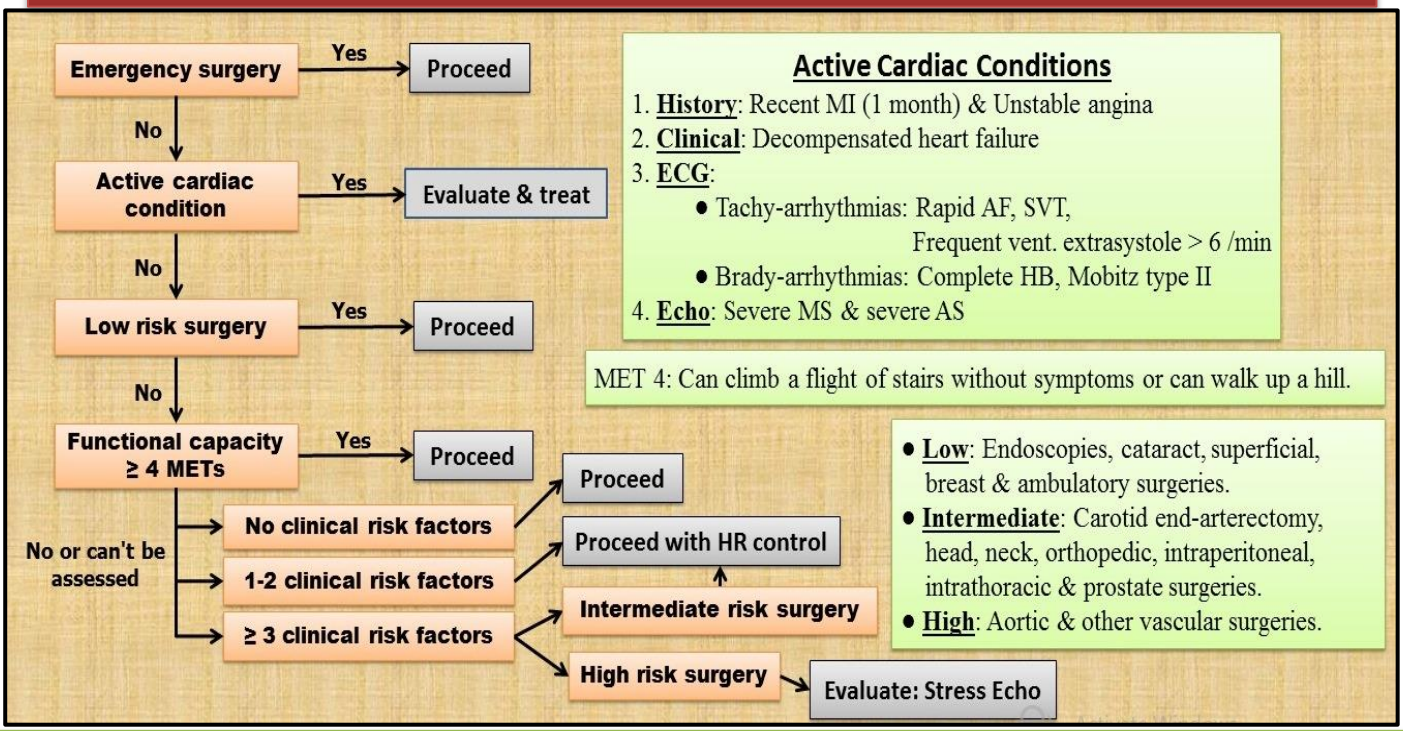
- Stop anticoagulation & anti-platelet therapy if:

  Platelet count < 50,000 or 30,000 in high risk patient … Or INR 2 - 3.
- In case of thrombocytosis > 1,000,000 → Give aspocid.
- Blood transfusion causes temporary ↑↑ TLC.

Sgarbossa Criteria: For diagnosing STEMI with left BBB

- Concordant ST elevation > 1 mm in leads with positive QRS complex (score 5).
- Concordant ST depression > 1 mm in V1-V3 (score 3).
- Excessively discordant ST elevation > 5 mm in leads with a –ve QRS complex (score 2).

ASSESSMENT OF CARDIAC PATIENT FOR NON-CARDIAC SURGERY



Clinical risk factors

Major: Unstable or severe angina, recent MI, decompensated HF, significant arrhythmia, severe MS or AS.
Intermediate: History of IHD, compensated HF, cerebrovascular disease or renal impairment.
Minor: Age > 70 years, left ventricular hypertrophy, left BBB, ST-T abnormality & uncontrolled HTN.

ARRHYTHMIA

Causes of arrhythmias

1) **Cardiac Diseases**
   - ♦ Pericarditis, myocarditis, infective endocarditis, RHD, conduction abnormalities & ischemia.

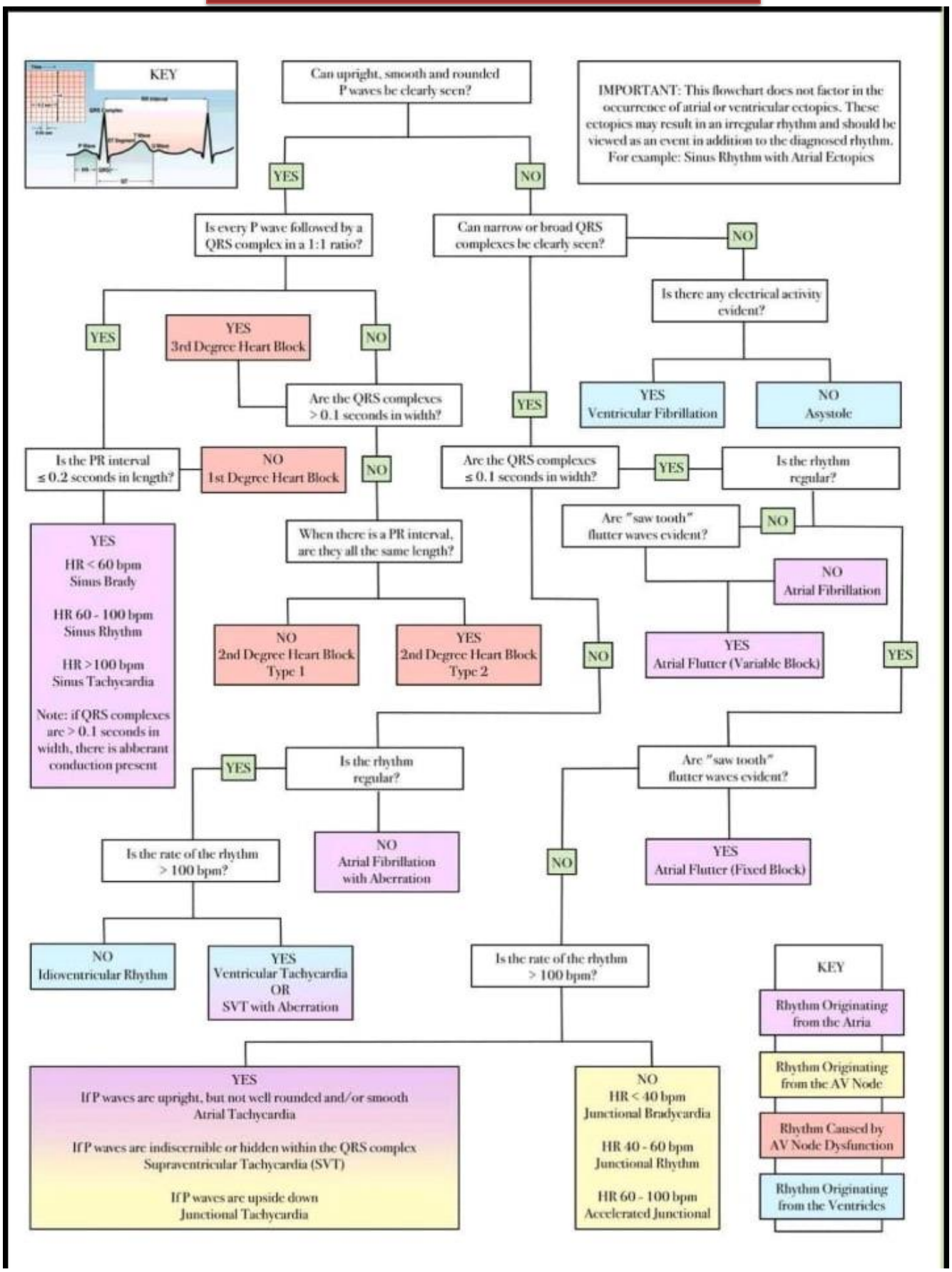
2) **Non-cardiac diseases**
   - ♦ Hypo/Hyper-hormones → e.g, hyperthyroidism & myxedema.

3) **Drugs**
   - ♦ Anaesthetic drugs → e.g, halothane.
   - ♦ Non-anaesthetic drugs:
     - Parasympathomimetics & Sympathomimetics.
     - Parasympatholytics & Sympatholytics.
     - Anti-arrhythmic drugs → as propafenone.

4) **Neuro**
   - ♦ Stimulation of areas rich in nerve supply: perineum, ear, nose & carotid body.
   - ♦ Central: tumor, trauma & hemorrhage.
   - ♦ Peripheral: pain & urinary bladder retention.

5) **Blood gases abnormalities**
   - ♦ pH: acidosis or alkalosis
   - ♦ Oxygen & CO2 abnormalities
   - ♦ Electrolyte disturbances

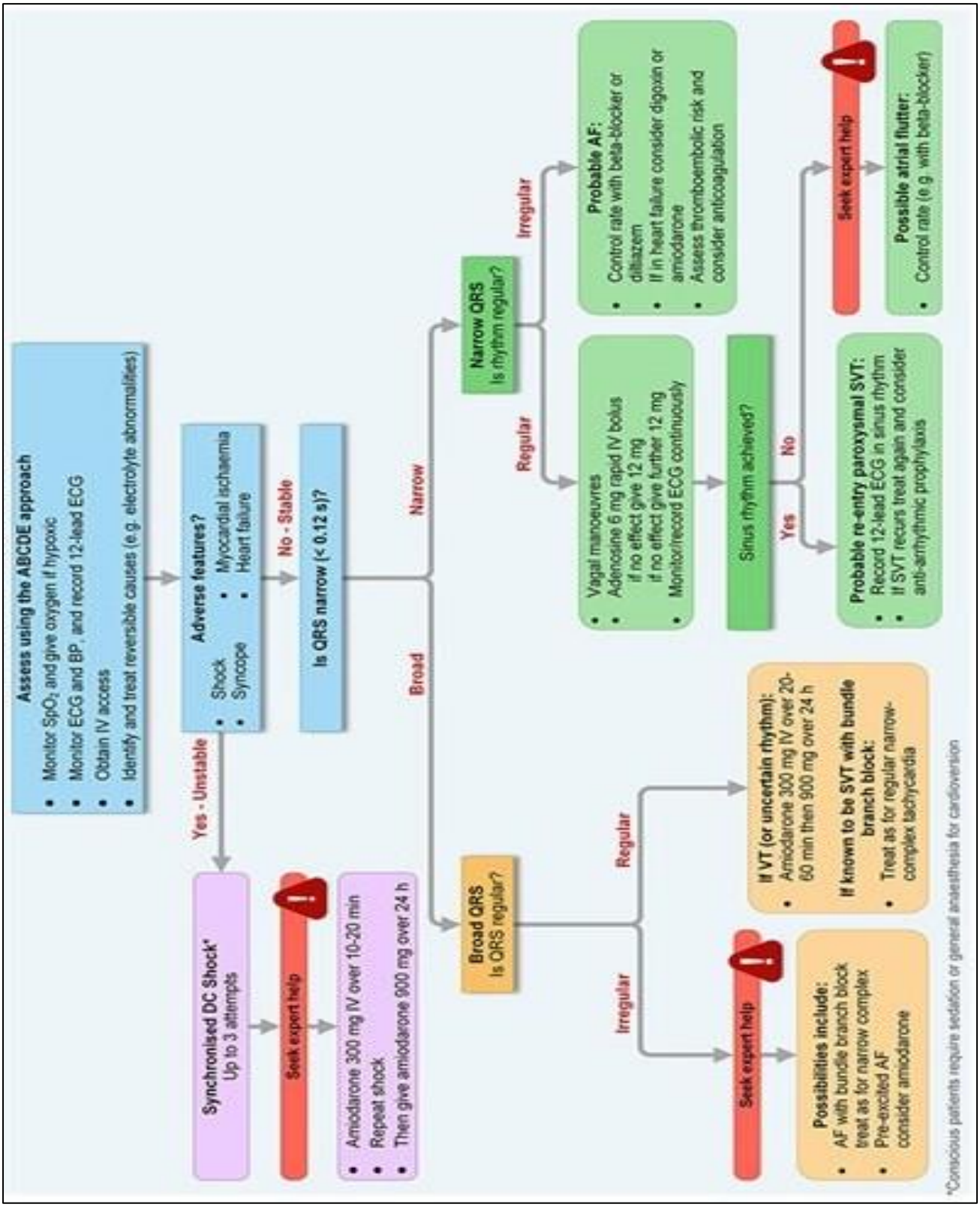
Cardiac Rhythm Analysis Flow Chart



TACHY-ARRHYTHMIA

Initial Management

- ♦ ABC
- ♦ 1. 12-leads ECG 2. ABG 3. Electrolytes 4. IV access 5. Oxygen



- DC of a patient with sinus tachycardia → worsen the condition.

- A patient presented with arrhythmia for the first time → Give 150 mg of cordarone (not 300 mg).

- In case of local anesthetic toxicity presented tachy-arrhythmia → Never give CCB.

- Side effect of adenosine → Bronchospasm.

- CCB should not be given in a patient with EF < 40%.

- In case of local anaesthetic toxicity presented tachy-arrhythmia → Never give CCB.

- Beta blockers are contraindicated in asthmatic patients.

- DC shock should be preceded with sedation & analgesia (dormicum & fentanyl).

Doses/Details
Synchronized cardioversion: Initial recommended doses: • Narrow regular: 50-100 J • Narrow irregular: 120-200 J biphasic or 200 J monophasic • Wide regular: 100 J • Wide irregular: defibrillation dose (*not* synchronized) **Adenosine IV dose:** First dose: 6 mg rapid IV push; follow with NS flush. Second dose: 12 mg if required.
Antiarrhythmic Infusions for Stable Wide-QRS Tachycardia **Procainamide IV dose:** 20-50 mg/min until arrhythmia suppressed, hypotension ensues, QRS duration increases >50%, or maximum dose 17 mg/kg given. Maintenance infusion: 1-4 mg/min. Avoid if prolonged QT or CHF. **Amiodarone IV dose:** First dose: 150 mg over 10 minutes. Repeat as needed if VT recurs. Follow by maintenance infusion of 1 mg/min for first 6 hours. **Sotalol IV dose:** 100 mg (1.5 mg/kg) over 5 minutes. Avoid if prolonged QT.

ATRIAL FIBRILLATION

AF ASSOCIATED WITH INSTABILITY

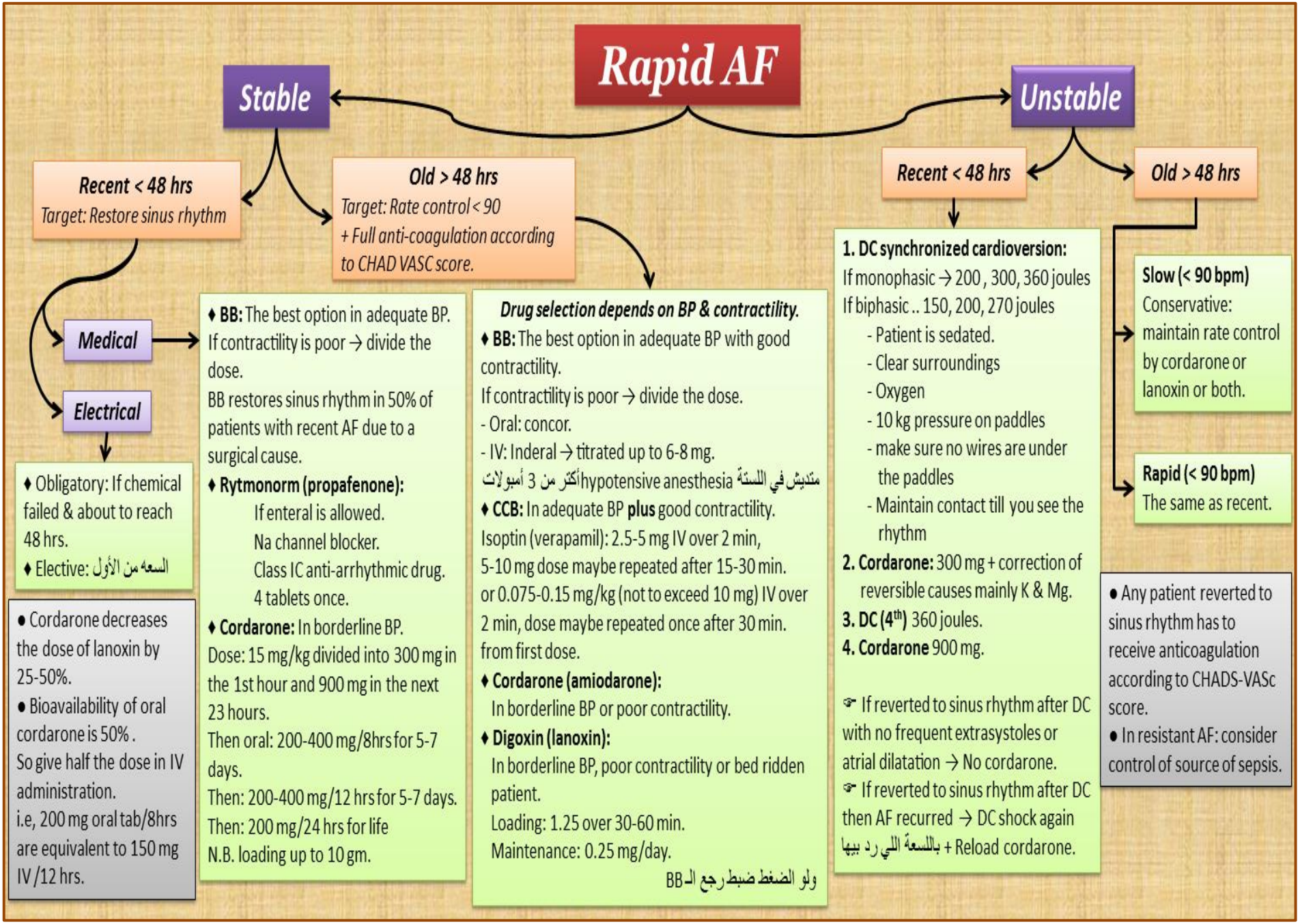
Signs of instability:

1. SBP < 90 or MAP < 65 mmHg.
2. Cardiac ischemia or failure: chest pain, ECG changes, ↑↑ cardiac enzymes or pulmonary edema.
3. Cerebral ischemia: DCL.

Recent AF (less than 48 hours)	Old AF (more than 48 hours)
DC synchronized cardioversion: If monophasic → 200,300,360 joules ... If biphasic → 150,200,270 joules. Cordarone 300 mg over 1 hour → DC 360 J → Cordarone 900 mg over 24. أمبولين على 50 بمعدل 50 سم في الساعة ... و6 أمبولات على 50 بمعدل 2 ☜ لو العيان رد sinus ومفيش frequent extrasystoles ولا atrial dilatation مش بنكمل الـ cordarone . ☜ لو العيان رد sinus وبعدها رجع تاني AF يتلسع تاني بالـ DC اللي رد عليها ونعمل cordarone reloading . Cordarone dose: 5 mg/kg over 1 hr then 15 mg/kg over 24 hrs.	♦ HR > 100 → DC & Cordarone as recent AF. ♦ HR < 100 → Maintain rate control: Cordarone or lanoxin or both. Search for another cause for instability.

AF IN VITALLY STABLE PATIENTS

Recent AF (less than 48 hours)	Old AF (more than 48 hours)
Target → Rhythm control (restore sinus rhythm).	Target → Rate control (< 100) + Full anticoagulation according to CHADS-VASc score
➢ **Medical** ♦ **BB:** The best option in adequate BP. ♦ **Rytmonorm (propafenone):** Na channel blocker, Class IC anti-arrhythmic drug → 4 tablets once. ♦ **Cordarone:** In borderline BP. ➢ **Electrical** ♦ Obligatory: If chemical failed & about to reach 48 hr. ♦ Elective: السعه من الأول N.B: Beta blockers restore sinus rhythm in 50% of cases with recent AF	***Drug selection depends on BP & contractility.*** ♦ **BB:** The best option in adequate BP with good contractility. If contractility is poor with adequate BP → Give low dose BB → Add cordarone if HR is still uncontrolled with development of borderline BP. Oral concor. or IV Inderal → titrated up to 6-8 mg. متديش في اللستة hypotensive anesthesia أكتر من 3 أمبولات . ♦ **CCB:** In adequate BP **plus** good contractility. Isoptin (verapamil): Titrated up to 20 mg (4 amp). or Loading: 0.15 mg/kg, then 0.075 mg/kg can be given every 10-15 minutes. ♦ **Cordarone (amiodarone):** In borderline BP or poor contractility. ♦ **Digoxin (lanoxin):** In borderline BP, poor contractility or bed ridden patient. Loading: 1.25 over 30-60 min. Maintenance: 0.25 mg/day. Cordarone can be added if HR is not controlled.



Score (points)	CHADS-VASc Risk Criteria	CHADS-VASc Score	Recommendation
1	Congestive HF	0	None
1	Hypertension		
2	Age ≥ 75 years		
1	Diabetes	1	Aspirin
2	Stroke/TIA/Thromboembolic event		
1	Vascular disease (prior MI/PAD/Aortic plaque)		
1	Age 65 - 74 years	> 1	Therapeutic anticoagulation
1	Sex category: Female sex		

☜ لو عيان AF رد sinus ← ياخد therapeutic anti-coagulation أو مياخدش على حسب score بتاعه ← لو هياخد يبقى لمدة شهر إلى 3 شهور .

☞ ***Patients with chronic controlled AF on therapeutic anticoagulation*** can be electrically cardioverted to sinus rhythm regarded that there is NO atrial dilatation by trans-thoracic echo **Plus** No atrial thrombus by TEE or Therapeutic anticoagulation for 2-4 weeks before cardioversion.

☞ ***Therapeutic anticoagulation:***

For patients in ICU → Clexane or heparin... After discharge from ICU: Marivan (warfarin).

☞ ***Cordarone***

- ***Loading dose includes:*** 300 mg IV over 1 hr → 900 mg IV over 24 hrs → 200 mg tab/8 hrs for 5-7 days → 200 mg tab/12 hrs for 5-7 days.
- ***Maintenance dose:*** 200 mg tab/24 hrs.
- ***Bioavailability of oral cordarone:*** 50% → If oral intake is contraindicated → 200 mg tab/8hrs can be replaced by 150 mg amp/12 hrs.
- ***Advese effects:*** Thyroid dysfunction, IPF & teratogenicity.
  Mothers must not lactate their infants after cordarone administration (even a single dose) → hypothyroidism .... Half life: 40-50 days.

☞ ***Lanoxin***

- A drug with a narrow therapeutic window, i.e, toxicity occurs easily & close monitoring is mandatory especially in renal patients(bradycardia).
- A weak drug that can't be used in active patients.

☞ ***Marivan***

- **C**CB, **C**ordarone, **D**iflucane, **D**aktarin oral gel, **E**ltroxin & **F**ibers-rich food → ↑ marivan effect.
- Diet (greens rich in vitamin K) & Epanutin → ↓ marivan effect.
- Depends on shipping containers.

☞ ***Procorolan:*** Used only in sinus tachycardia ... Contraindicated in presence of arrhythmia.

Supraventricular Tachycardia

- UNSTABLE →→→ DC shock.
- STABLE →→→ **A**denosine, **B**B, **C**CB, **C**arotid massage, **C**ordarone, **D**igoxin
  According to BP & contractility.

How to Switch Between Anticoagulants

From	To	How to switch
Heparin	NOAC	Start NOAC at the time of heparin discontinuation
LMWH / fondaparinux	NOAC	Stop LMWH / fondaparinux and start NOAC ≤ 2 hr before next scheduled LMWH/fondaparinux dose
Warfarin	NOAC	Stop warfarin and start dabigatran/apixiban when INR < 2.0 Stop warfarin and start rivaroxaban when INR < 2.5
Dabigatran	Warfarin	CrCl > 50ml/min: start warfarin 3 days before stopping dabigatran CrCl 31–50ml/min: start warfarin 2 days before stopping dabigatran CrCl 15–30ml/min: start warfarin 1 day before stopping dabigatran CrCl <15ml/min: no recommendations provided
Rivaroxaban Apixaban	Warfarin	Start warfarin with rivaroxaban/apixaban until INR ≥ 2.0 and then stop rivaroxaban/apixaban (INR testing should be done just before rivaroxaban/apixaban dose)
NOAC	Parenteral anticoagulants	Stop NOAC and start parenteral anticoagulant 12 hours after last apixaban/dabigatran dose and 24 hours after last rivaroxaban dose
NOAC	Different NOAC	Administer new agent when next dose is due

High Thromboembolism Risk Perioperative Bridging

Day	Anticoagulation Plan
Pre-op Day 5	Stop warfarin (last dose on Pre-op Day 6).
Pre-op Day 3	Start therapeutic enoxaparin bridging (1 mg/kg SC q12h) or heparin infusion when INR < goal range.
Pre-op Day 1	Check INR, give vitamin K 1.25-2.5 mg orally if INR > 1.5. Last dose of therapeutic enoxaparin (if using) must be > 24 hours prior to surgery.
Day of Surgery	Check INR, consider additional vitamin K if INR > 1.5. Stop heparin infusion (if using) 4-6 hours prior to surgery. Assess hemostasis postoperatively. May resume warfarin evening of surgery if patient taking fluids.
Post-op Day 1	Standard bleeding risk: Resume therapeutic enoxaparin or heparin infusion 24 hours after surgery if hemostasis achieved. High bleeding risk: Consider no bridging or low-dose enoxaparin (40 mg SC daily) 24 hours after surgery if hemostasis achieved.
Post-op Day 2	High bleeding risk: Resume therapeutic enoxaparin or heparin infusion 48-72 hours after surgery if hemostasis achieved.
Post-op Day 4+	Discontinue bridging when INR in goal range.

POST-ARREST PROTOCOL

Post-arrest syndrome

1) **BRAIN INJURY** →→ Causes late death.
   - ♦ Convulsions → Myoclonus & Tonic clonic
   - ♦ Brain stem death
   - ♦ Coma
   - ♦ Cognitive dysfunction
   - ■ Don't put the patient on muscle relaxant unless EEG is available as it will mask convusions.

2) **MYOCARDIAL DYSFUNCTION** →→ Causes early death.
   - ♦ Hemodynamic instability
   - ♦ Arrhythmia
   - ♦ Myocardial infarction

3) **SYSTEMIC ISCHEMIA & REPERFUSION RESPONSE**
   - ♦ Impaired coagulation (DIC).
   - ♦ Vasoplegia due to reperfusion + endothelial damage & ↑ intravascular space.
   - ♦ Impairment of immune system (infection).
   - ♦ Myocardial infarction.

4) **PICTURE OF THE PRECIPITATING FACTOR**
   - ♦ Hypovolemia, Hypoxia, Hydrogen ion excess (acidosis), Hypo/Hyperkalemia & Hypothermia.
   - ♦ Tension pneumothorax, Tamponade, Thrombosis (pulmonary or cardiac) & Toxins.

To prevent secondary brain insult you should prevent:
- ★ Hypo & Hyperglycemia
- ★ Hyperpyrexia & Rapid rewarming
- ★ Hypo & Hyperoxia
- ★ Convulsions
- ★ Hypotension

Management

1) **AIRWAY** →→ No need for intubation provided that:
   - ♦ ROSC after 1 cycle
   - ♦ Return of all intellectual functions
   - ♦ SO_2 > 94% even on oxygen mask
   - ♦ Hemodynamically stable

Avoid hyperoxia ... Use the minimal fiO_2 that achieves SO_2 > 94% .

2) **BREATHING**
   - ♦ Once intubated → insert a ryle.
   - ♦ PEEP: 4-8
   - ♦ TV: 6-8 ml/kg
   - ♦ Avoid hyperventilation & maintain PCO_2 around 40 mmHg to achieve a better neurological outcome.
   - ♦ If sedation was started → don't interrupt before 24 hours.
   - ♦ If tracium is needed for any reason (as ARDS) → EEG is mandatory.

3) **CIRCULATION**
   - ♦ Fluid administration according to fluid responsiveness.
   - ♦ Avoid hypotonic solutions.
   - ♦ Avoid glucose containing solutions except in hypoglycemia ... Start ryle feeding early to prvent it. use glucose 25% if you have to.
   - ♦ Inotropic support →→ nor-adrenaline, adrenaline ± dobutamine (if $ScVO_2$ < 65%).
   - ♦ Serial echo →→ compare contractility.

✪ *The myocardium starts to recover 2-3 days after ROSC.*
✪ *In case of dilated fixed pupil → wait for 24 hours & reassess.*

- ♦ Hemodynamic goals:
  - MAP > 65 mmHg (> 85 mmHg if hypertensive) with systolic BP > 100 mmHg.
  - UOP > 0.5 ml/kg/hr.
  - Mixed venous saturation: 70%.
  - HR: bradycardic side, If UOP & BP ***(Volume – BP – Perfusion)*** are maintained with ↓↓ lactate → HR down to 40 is accepted.
  - Keep eye on serum K+ → transient ↑↑ then it ↓↓ due to intracellular shift by the effect of catecholamines → may lead to arrhythmia up to arrest.

- Correct electrolytes before DC & cordarone.
- Maximum cerebral VC: $PCO_2 \leq 20$ mmHg ... Maximum cerebral VD: $PCO_2 \geq 80$ mmHg.

4) DISABILITY

a) Cerebral perfusion:

Maintain MAP between 60-160 … If cerebral perfusion was affected →→ multifocal cerebral no flow (takes seconds), global cerebral ischemia (15-30 min) & cerebral hypoperfusion (24 hrs).

b) Sedation:

- ♦ Once started → don't interrupt before 24 hours.
- ♦ It prevents shivering … achieved by dormicum, diprivan & desflurane ??

c) Convulsions:

- ♦ Tonic clonic → Treated by epanutin (phenytoin), tiratam (levetiracetam), intraval, sodium valproate & diprivan.
- ♦ Myoclonus → Epanutin is not effective, treated by tiratam & diprivan.

d) Glycemic control:

- ♦ Conventional (around 180).
- ♦ Tight (80-110) → High incidence of hypoglycemia → should be avoided
- ♦ Hypothermia → ↑↑ insulin resistance.

e) Hypothermia (Target temperature management):

- ♦ Not necessary (evidence c) → Body temperature around 37^O is accepted.
- ♦ Mechanism →↓↓ CMR.
- ♦ Target: 33^O-36^O.
- ♦ Rewarming: 0.25^OC - 0.5^OC per hour.
- ♦ Achieved by:
  - 30 ml/kg cold saline.
  - Cold saline in enema, ryle & urinary bladder.
  - Complete removal of clothes.
  - Washing the body with alcohol.
  - Ice or air blanket.
  - $MgSO_4$ → stops shivering.
  - ECMO or dialysis.
- ♦ Side effects:
  - Shivering: stopped by sedation, muscle relaxation, $MgSO_4$ & NMDA antagonists.
  - ↑↑ SVR & arrhythmias like bradycardia.
  - Diuresis + ↓↓ electrolytes.
  - Hyperglycemia.
  - Infections → Give prophylactic antibiotics as they ↑↑ survival rate.
  - ↑↑ Amylase.
  - ↓↓ Metabolism of drugs (34^O → ↓↓ metabolism by 30%).
  - Impaired coagulation (no study).
- ♦ Contraindications:
  - Pre-existing coagulation disorder.
  - Sepsis.

ACUTE KIDNEY INJURY

RIFLE classification قديم

- **Risk →** ↑↑ creatinine by 50% of baseline level (1→1.5) , UOP < 0.5 mL/kg/hr for 6 hours.
- **Injury →** ↑↑ creatinine by 100% of baseline level (1→2) , UOP < 0.5 mL/kg/hr for 12 hours.
- **Failure →** ↑↑ creatinine by 200% of baseline level (1→3) , UOP < 0.3 mL/kg/hr for > 24 hours.
- **Loss →** Complete loss of kidney function (anuria) for > 4 weeks …"necessitates dialysis".
- **End-stage kidney disease →** Complete loss of kidney function (anuria) for > 3 months.

KDIGO staging

- **Stage 1 →** ↑↑ creatinine by ≥ 0.3 mg/dL within 48 hours, UOP < 0.5 ml/kg/hr for 6-12 hrs or ↑↑ creatinine 1.5 - 1.9 times baseline over 7 days.
- **Stage 2 →** ↑↑ creatinine to 2.0 - 2.9 times baseline or UOP < 0.5 ml/kg/hr for ≥ 12 hrs.
- **Stage 3 →** ↑↑ creatinine to 3.0 times baseline, UOP < 0.3 ml/kg/hr for ≥ 24 hrs, anuria for ≥ 12 hr or ↑↑ creatinine to ≥ 4.0 mg/dL or initiation of renal replacement therapy.

High risk patients for AKI

- **عيان** →→ Chronic renal impairement, hepatic patients.
- **عمليات** →→ Vascular surgery, biliary surgery, massive debridement.
- **صبغة** →→ Urographine, massively crushed limb, bilirubin (obstructive jaundice).
- **Sepsis & Trauma.**
- **Nephrotoxic Drugs.**

Indications of dialysis

Clinical "Only in renal patients" → Systems	Laboratory
1. CNS: DCL (uremic encephalopathy). 2. CVS: Pericarditis (pericardial rub). 3. Respiratory: Pulmonary edema. 4. GIT: Persistent vomiting.	1. pH < 7.1 or HCO_3 < 10 2. Refractory hyperkalemia > 6.5 3. Creatinine > 10 or rising by > 1 per day (disregard in critical patients). 4. Urea > 200

- Don't rush to dialysis in unstable patients unless there is a profound indication: Severe acidosis, hyperkalemia or pulmonary edema.
- Single session then reassess.

Management of AKI

Post-renal & Pre-renal

❶ Exclude post-renal causes:

- Check the urinary catheter for obstruction.
  سلك القسطرة أو غيرها أولو في conduit اتأكد إنه شغال.
- Perform abdominal ultrasound to detect backpressure changes (exclude stone).
- Palpate the bladder (even if there is no catheter obstruction) especially after TURP or trauma as urethral injury may cause a false track → Ultrasound: distended bladder with no renal backpressure changes → managed by suprapubic cystocatheter.

❷ Exclude pre-renal causes:

a) Assess the volume status:

1. Static (CVP): Target CVP: 12 cmH_2O in spontaneously breathing patients, 15 cmH_2O in ventilated ones.
2. Dynamic (Cardiometry, Echo & PPV).
3. ميزان خصوصا العيانين اللي في بيتهم

b) Target MAP > 65 mmHg (> 85 mmHg in hypertensive patients).

c) Assess the perfusion:

1. lactate, 2. Capillary refill
3. Mixed venous SO_2 > 70%, central venous SO_2 > 65%
   If less → ↑↑ Hb > 9 gm/dl
   If still low → Dobutamine infusion لو ضغطه يسمح
4. CO_2 gap (central venous CO_2 - arterial CO_2): > 6 mmHg is a bad sign.
5. In case of high intra-abdominal pressure (> 15 mmHg) → Target MAP will be > 85 mmHg even if not a hypertensive patient.

Stop nephrotoxic drugs unless lifesaving → taken on dialysis.

Intrinsic renal

❸ Management of intrinsic renal:

1. Check balance every 4 hours with Fluid restriction to avoid congestion.
2. Cautious potassium supplementation.
3. Adjust drugs according to creatinine clearance. KIDGO stage 3 = Cr. clearance < 10 .
4. U/S to detect backpressure changes
5. Diuretics:
   20-40 mg shots over 5 minutes.
   60-120 mg over 20 minutes.,
   160-200 mg over 40 minutes.

Start with the high doses if the patient is already on diuretics.

Patients who have a partial but inadequate diuresis with bolus therapy can be treated with Continuous intravenous infusion.

Patients who have no response to the maximal dose of bolus therapy should not be treated by continuous infusion

6. Dialysis
7. Work up of the kidney

❹ Renal protection against dyes:

1. Stop NSAIDs 24 hours before adminitration
2. If fluid responder or fasting: Normal Saline 1 ml/kg/hr for 6 hours before and 6 hours after
3. Bicarb has no role in prevention of nephrotoxicity nor does any other drug.

Hidonac (high dose N-acetyl cysteine IV)

Indications:

- Paracetamol toxicity (common in ICU in pediatrics).
- Liver cell failure.
- Used to have a role in renal protection against dye.

Dose:

150 mg/kg for thr first hour.
12.5 mg/kg/hr for 4 hours.
6.25 mg/kg/hr for 24 hours.

Hyperkalemia

☞ Serum K^+ > 5.5 mEq/L.
☞ Clinical picture:

1. Muscle weakness
2. ECG changes: hyperacute T (> 2 LS in chest leads & 1 LS in limb leads), prolonged PR & wide QRS.
3. Finally cardiac arrest in diastole.

☞ **Anti-hyperkalemic measures**

1. Stop potassium intake.
2. Protect the heart → 3 ampoules of calcium gluconate or 1 ampoule of calcium chloride → "CVL".
3. ↑↑ Intracellular shift of potassium:
   - ♦ β_2 agonist: farcolin (salbutamol).
   - ♦ Alkalosis: metabolic ($NaHCO_3$) & respiratory (hyperventilation).
     N.B, For every 0.1 decrease in pH → K increases by 0.8.
   - ♦ Glucose-insulin: 1-2 units of insulin added to 5 gm glucose
     = 10 - 20 IU to 200 ml of glucose 25% **bolus** every 6 hours جري المحلول ع الآخر عشان يجيب نتيجة .
4. ↑↑ Potassium loss:
   - ♦ Lasix shots up to infusion as before.
   - ♦ Potassium chelating agents (sorbisterit) → very effective.
   - ♦ Dialysis if K^+ > 7 + ECG changes.

Potassium Replacement Therapy

- 5 ampoules/50 ml saline → Rate 15-20 ml/hr "central line".
- Chronic hypokalemia → Give 10 ampoules then reassess:
  If mild ↑↑ → Give another 10 ampoules… If > 4 → stop K^+ infusion.
- Maximum dose → 24 ampoules in 24 hours.
- Renal patients with hypokalemia: Cautious correction "2 ampoules then reassess" → Target: 3.5 mEq/L.
- Potassium level: Intracellular: 135 … Extracellular: 3.5-5.5

لما تيجي تركب ماهوركر لعيان End-stage renal disease

- نظافة كتيييير "disinfection".
- Site: Rt IJV > Femoral > Lt IJV > Subclavian.
- شكة واحدة في subclavian vein بتعمل 50% stenosis فارحم أم العيان D:
- قول للعيان يعمل قرار في أسرع وقت عشان يعمل الوصلة وميتأخرش لأنها أصلا بتشتغل بعد فترة وخلال الشهر ده هيكون اتشك في كل حتة في جسمه ومبقاش نافع يعمل وصلة خلاص .

Intra-abdominal pressure

☞ Intra-abdominal pressure is very important because renal perfusion pressure is equal to MAP – (2 X IAP).

☞ Suspect high IAP in the following conditions:

- Major trauma/ burn
- Abdominal surgery with tight closure
- Liver tear closed with packs
- Tense ascites
- Massive transfusion

☞ If IAP is high (> 15 mmHg) a higher MAP is desirable (80-85 mmHg).

☜ نقيسه ازاي: والعيان supine ... احقن 15-20 سم ملح في قسطرة البول ووصلها بجهاز وريد .

Rhabdomyolysis

♦ **Diagnosis:** Rise of CK level 5 to 10 times above normal value.
CK > 5000 IU/L increases the risk of AKI.

♦ **Causes:**

Direct muscle trauma:

- Trauma, Burn, Electrocution, Seizures, Hyper or hypothermia.

Non traumatic causes:

- Electrolyte disturbance: ↓ Ca, ↓K, ↓Na, ↑Na.
- Alcohol.
- Medications: statins, benzodiazepins, antidepressants.
- Sepsis.

♦ **Treatment:**

- Normal saline or Ringer lactate infusion at 3-5 ml/kg/hr till CK level decreases.
- Target UOP > 100 ml/hr.
- If normo or hypervolemic → Mannitol or Lasix can be given.
- If acidotic → Give half normal saline + 50 mEq $NaHCO_3$ to every liter at a rate of 125 ml/hr until urinary pH > 6.5 or serum pH > 7.5

CHRONIC KIDNEY DISEASE

Investigations to be done

1. **Ultrasound** → To detect the grade of nephropathy.
2. **Albumin/Creatinine ratio** → Presence of albumin in urine indicates renal disease → treated by ACEI, ARBs or CCB.
3. **Parathormone level** → ↑↑ in case of hypocalcemia (secondary hyper-parathyroidism).
4. **Iron profile.**
5. **Electrolytes:** K^+, Na^+, Ca^{+2}, PO_4 & Mg^{+2}.
6. **Urine analysis:** ↑↑ casts in ATN, ↑↑ WBCs in interstitial nephritis, ↑↑ RBCs in vasculitis.
7. **Echo every 6 months**

Management

1. **Anemia (Hb < 10 gm/dl).**
   In case of ↓↓ iron level → Give eprex (erythropoietin) + ferosac (iron).
   In case of normal iron level → Give eprex only.
2. **Hypocalcemia:**
   In case of ↓↓ ionized calcium → Give calcimate.
   If Ca X PO_4 < 50 → Give one alpha (active vitamin D).
   If Ca X PO_4 > 50 → Don't give one alpha.

   ☞ For each ↓↓ 1 gm of albumin below 4 gm/dl →→ Calcium decreases by 0.8 .
3. **Statins**

Nephrotoxic Drugs commonly used in ICU:

- Amikacin	- Amphotericin B	- Vancomycin
- NSAIDs	- Colistin	- ACEI
- Cerebrolysin ??	- Aldactone	- Dye

Medications commonly associated with acute tubular necrosis:

- Aminoglycosides.
- NSAIDs.
- ACEIs & ARBs.
- Amphotericin
- Others: cisplatin, iodinated contrast

Medications requiring dose adjustment or cessation in AKI

- Analgesics: morphine, pethidine, gabapentin, pregabalin.
- Digoxin
- LMWH (clexane)
- New oral anti-coagulants
- Antifungals: fluconazole.
- Antibiotics (Most of them).
- Antivirals: acyclovir.
- Lithium
- Antiepileptics: lamotrigine.
- Oral hypoglycemic drugs: sulfonylureas, metformin.

DIABETIC KETO-ACIDOSIS

♦ Usually: type 1 DM, missed dose, eats a lot.

Risk factors → Trauma - Surgery - Infection - Pregnancy.

Clinical picture

- **CNS** →→ Drowsy or comatose.
- **CVS** →→ Tachycardic with borderline blood pressure.
- **Respiratory** →→ Tachypnic with acetone odor (Kausmall breathing).
- **GIT** →→ Vomiting with abdominal colic (acute abdomen).
- **Renal** →→ Polyurea.

Diagnosis

- **RBS** > 250 mg/dl — N.B: 25% of cases may be euglycemic.
- **Acetone in urine** →→ Positive — N.B: may be negative.
  - Acetoacetic acid appears late & disappears late (detectable in urine & blood).
    End-stage renal disease اللي في الدم بنعمله لو عيان مش بيجيب بول زي عيان
  - β-hydroxybutyric acid appears early (detectable in blood only), وغير موجود في مصر
- **ABG** →→ Metabolic acidosis with **high anion gap**.

Management

1) ABC

2) FLUIDS

Volume	***Mechanism of action***
➢ Adults: 1000 ml .. 30 min. 1000 ml .. 1 hour 500 ml .. 1 hour Then 250 ml for every hour after that guided by fluid status & UOP. ➢ Pediatrics: Give 20 ml/kg of normal saline as a bolus. Give another bolus in shocked patients. Then give double the maintenance.	1. Correction of dehydration & improvement of perfusion. 2. Dilution of anti-insulin hormones. 3. ↑↑ sensitivity of insulin receptors.

Type

According to corrected Na^+ level →→ Serum Na^+ + (1.6 x $\frac{RBS-150}{100}$)

As each 100 mg/dl of blood glucose above normal "150" leads to a decrease of Na^+ level by 1.6.

e.g, serum Na^+: 145, RBS: 550 → Corrected Na^+ = 145 + (1.6 x $\frac{550-150}{100}$) = 145 + 6.4 = 151

➢ If corrected Na^+ level is high → give half normal saline.

➢ If normal or low: give normal saline.

✪ If RBS < 250 mg/dl → give 1-2 ml/kg/hr glucose (5% or 10% or 25% according to glucose level) + normal saline + half dose of insulin.

☞ The volume of infused glucose should be subtracted from the deficit.

3) INSULIN

♦ Give a bolus of 0.1 unit/kg of regular insulin IV then 0.1 unit/kg/hr.

♦ Check RBS hourly.

♦ The blood glucose level should decrease by 70-100 mg/dl per hour.

If > 100 →→ ↓↓ insulin infusion to ½ dose (0.05 unit/kg/hr).

♦ Resistant DKA, DKA in cardiac & renal patients →→ double the dose of insulin.

♦ في مصر → Rate of infusion = $\frac{RBS}{100}$ → units/hr.

4) POTASSIUM

- Give 10 - 20 mmol/liter (ampoule / saline bottle).
- If serum K^+ < 3.3 →→ Hold insulin & correct hypokalemia first.
- Serum K^+ & ABG should be assessed every 4 hours.

5) BICARBONATE

Given only if pH < 7 .

6) TREATMENT OF PRECIPITATING FACTOR

- e.g, Control of infection: medical & surgical → e.g, debridement of diabetic foot.
- N.B. DKA + DCL / proptosis →→ suspect Mucormycosis →→ CT brain to diagnose →→ treated by fungizone (amphotericin B).

DKA in cardiac & renal patients
➢ Give fluids according to fluid responsiveness →→ Static (CVP) & Dynamic (Cardiometry, Echo & pulse pressure variation). قيس الـ CVP بعد كل 200 سم .
➢ Double the dose of insulin.
➢ Congested renal patient →→ Dialysis + fluid administration. اغسله وادي المحاليل أثناء الغسيل
➢ Congested cardiac patient →→ Lasix.
➢ Expected to be resistant because treatment of DKA depends mainly on fluids & not insulin.

☞ ***Resolution of DKA*** *امتى بنقول ان العيان فك* **?**

♦ HCO_3 > 18 for ≥ 2 readings ♦ Acetone-free (أسيتون قديم من الأول) من القسطرة نفسها مش من كيس جمع البول

☞ ***When to Shift to fixed insulin doses?*** After adequate oral intake → 2/3 of daily requirement of regular insulin → **Mixtard**: 2/3 in the morning & 1/3 at night ± oral hypoglycemic ...

Or Mixtard 0.5 - 1 unit/kg/day ± oral hypoglycemic

Or Lantos single dose at night + 3 doses of **Actrapid** before meals.

في أوروبا والدول المتقدمة فقط عشان الـ calories بتكون محسوبة في كل وجبة ... البكابورت مفيهوش 4 شكات D:

Hyperglycemic hyperosmolar non-ketotic coma
➢ Occurs in old patients without ketoacidosis.
➢ Usually in type 2 DM.
➢ Ketoacidosis may occur very late (starvation ketosis).
➢ Diagnosis →→ By plasma osmolarity > 320 (hyper-osmolarity). Plasma Osmolarity = (Na x 2) + (Glucose/18) + (Urea/2.8)
➢ Management : - Fluid resuscitation 15-20 ml/kg/hr up to 50 ml/kg/hr in severe dehydration guided by fluid status & UOP (the usual deficit is 9 - 12 liters). - Insulin + Potassium infusion as in DKA.

HEPATIC PATIENT

CHILD classification:

	Class A	Class B	Class C
Encephalopathy	No encephalopathy	Minimal	Advanced coma
Ascites	Absent	Slight	Moderate
Serum bilirubin	< 2 mg/dl	2-3 mg/dl	> 3 mg/dl
Serum albumin	> 3.5 g/dl	2.8 - 3.5 g/dl	< 2.8 g/dl
INR	< 1.7	1.7 - 2.2	> 2.2

☞ Incidence of mortality on table in Child C is > 40%.

☞ Child C → المحاليل مش هتجيب نتيجة حطه علي inotropes من الاول

Patients with chronic liver disease at home:

- ↑↑ liver enzymes → Give silymarin/ 8 hrs → cell membrane stabilizer.
  - ☞ Silymarin plus = silymarin + N-acetyl cysteine (contraindicated in pregnancy).
- ↑↑ bilirubin → Give ursofalk tablet/ 8 hrs or قرصين الصبح و قرص بالليل
  Assess direct/total bilirubin ratio + IHBR dilatation for possibility of obstructive jaundice → for ERCP.
- Give oral lactulose → Target is 2-4 motions/ day.
- In case of ascites or edema → Give aldactone or lasilactone according to severity & targeting ↓↓ weight.
  Aldactone in hepatic patients can be given in a high dose (100 - 400 mg/day).
  Aldactone is contraindicated if serum creatinine > 2 .
- Patients with history of hepatic encephalopathy → Give Gastrobiotic 550 mg / 12 hrs.
- Cirrhotic patients with history of SBP, GIT bleeding, ascites (ascitic fluid protein < 1.5 gm/dl) or renal impairment → Give Cipro 750 mg /week to prevent SBP.
- In case of anemia → Investigate for occult blood in stool → If positive: consider upper GI endoscopy.

6 Major Problems in Hepatic patients

❶ *Hepatic Encephalopathy*

♦ Clinical picture: Flapping tremors, disorientation, ↑↑ ammonia ...
لو عنده flapping tremors متستعجلش في خروجه حتى لو كان oriented .

♦ Lactulose enema added to oral lactulose.
بعد ما تتحقن مش بنفضيها عشان هتطلع clear وملهاش لازمة ... بنسيبها تعمل distension للقولون ويفضيها لوحده فيخرج الـ contents بتاعة القولون ... اتأكد إن التمريض بيعملها فعلاً.

♦ Hepamerz (L-oritine L-aspartate): combines with ammonia forming urea which is excreted by the kidney.
4 - 8 ampoules once daily (no intervals) → maximum 1 ampoule /hr ...
Contraindicated in renal impairment with serum creatinine > 3 (allowed in hemodialysis).

❷ *Hematemesis*

1. **ABC**.
   Border line conscious level with hematemesis is an indication for intubation to avoid aspiration.
   Two wide bore cannulae, CBC and cross matching for blood & plasma transfusion ± platelets.
2. **Gastric wash** with cold saline & adrenaline till it becomes clear.
   In non-intubated patients: 250 ml at a time to avoid regurgitation.
   look for air under diaphragm ← perforated DU لو مش بيطلعه يبقى احتمال يكون ... لازم اللي بياخده يطلعه
3. **3rd or 4th generation cephalosporin** for 5 days due to ↑↑ incidence of SBP with hematemesis!!

4. **PPI infusion: Controloc (pantoprazole) or losec (omeprazole)** → Only in DU … has no role in bleeding varices … 80 mg IV shot then 8 mg/hr → 2 vial / 50 ml → Rate: 5 ml/hr.
   After stabilization: It is given once, twice or infusion according to upper GI staging.
5. **Sandostatin (octreotide)** IV for 3 - 5 days → ↓↓ portal hypertension.
   25 - 100 µg bolus followed by 25 - 50 µg/hr for 3 - 5 days or ampoule SC / 6-8 hrs. (amp=100 µg).
6. **Coating drugs:** Mucosta, Maalox & Gaviscon → have no role with PPI.
7. **Upper GI endoscopy** after stabilization: Band ligation or sclerotherapy
   Or surgical control: Sengstaken tube.

❸ *Hepatorenal Syndrome*

Hepatic patient (cirrhosis & ascites)

1. Rising creatinine > 1.5 with no improvement after 2 days of volume expansion using albumin & diuretic withdrawal
2. Absence of shock
3. No current use of nephrotoxic drugs
4. Normal renal ultrasound.

Management : (same as AKI)

- Exclude post-renal → Flush the catheter.
- Exclude pre-renal → Ensure adequate fluid state (by static & dynamic measures).
- Management of intrinsic renal (see AKI) PLUS :
  1. Albumin: 2 vials/12 hrs + Lasix.
  2. Splanchnic VC:
     - Midodrine (α_1 agonist) 7.5 mg (3 tablets)/ 8 hrs **PLUS** Sandostatin (IV infusion or SC shots).
       OR Glypressin: Loading: 1 vial / 50 ml over 1 hour or direct IV shot.
       Maintenance: 1 vial / 50 ml → rate: 8 ml/hr.
       OR Levophed targeting ↑↑ MAP by 15 mmHg from baseline.
  3. Tapping to ↓↓ intra-abdominal pressure.
  4. Target Creatinine < 1.4 mg/dl

- Sandostatin & glypressin are relatively contraindicated in patients with IHD & absolutely contraindicated in acute coronary syndromes.
- Glypressin infusion is more effective than direct IV shot.

❹ *Spontaneous Bacterial Peritonitis*

Diagnosis :

1. Ascitic fluid analysis → Neutrophils > 250 cell/cmm + Culture & sensitivity.
2. ↑TLC, ↑CRP, fever & tense ascites with abdominal tenderness.

Management :

1. Albumin: 1.5 gm/kg on day1 then 1 gm/kg on 3 days.
2. Cefotaxime (claforan), if no improvement after 48 hours, hemodynamically unstable, hospitalized for 48 hrs or on antibiotics for 3 days → Shift to Tienam, Meronem or Tazocin.
3. Stop β-blocker عدو عيانين الكبد

❺ *Hepato-adrenal Syndrome*

Any hepatic patient on inotropic support (even minimal doses) should be supplemented with hydrocortisone 50 mg/ 6 hrs.

Indications of Albumin:

- ☞ Hepatorenal syndrome.
- ☞ Spontaneous bacterial peritonitis.
- ☞ Hypovolemia, Burn (> 50%) & Septic shock in case of extensive resuscitation (30ml/kg) → Albumin 5%.
- ☞ Plasmapharesis.
- ☞ Ovarian hyperstimulation syndrome with hypovolemia (in volume depletion otherwise use crystalloids).
- ☞ Tapping: after the 5th liter → Give 1 vial for each 1 liter.
- ☞ Liver transplantation to restore lost volume or drain losses (albumin 5%).
- ☞ Nutritional hypo-albuminemia if serum albumin < 2 gm/dl. فتي
- ☞ Moderate pleural effusion with hypo-albuminemia → Give albumin + Lasix. فتي

Stop β-blocker in hepatic patient with:

- ☞ Hepatorenal syndrome.
- ☞ SBP.
- ☞ Refractory ascites.
- ☞ Systolic BP < 100 mmHg or MAP ≤ 82 mmHg.
- ☞ Serum Na^+ < 120 mEq/L.
- ☞ Acute kidney injury

These conditions → ↓cardiac reserve → ↑mortality.

Indications of tapping:

- ☞ Respiratory distress.
- ☞ Hepatorenal syndrome to ↓↓ IAP → ↑↑ renal perfusion.

If massive pleural effusion → pig tail over chest tube (personal experience)

- Albumin 20% vial → 50 ml containing 10 gm of albumin.
- Albumin 5% → prepared by adding 2 vials of albumin 20% to 400 ml Ringer.

IV FLUIDS

	Normal saline	Ringer's solution	Lactated Ringer's	Ringer acetate
Na^{+}	154	147	130	130
Cl^{-}	154	156	110	110
Ca^{+2}	-	4.5	2	2.5
K^{+}	-	4	4.5	4.5
Lactate	-	-	30	-
Acetate	-	-	-	30
Osmolarity	308	312	273	273

Fluid infusion sets

	Venous line	Blood transfusion line	Soluset
1 ml equals ?	15 drops	10 drops	60 drops
Number of drips (per minute) to give a certain volume (per hour).	Target volume / 4 To give 100 ml/hr → 100/4 = 25 drops/min.	Target volume / 6 To give 120 ml/hr → 120/6 = 20 drops/min.	Target volume / 1 To give 100 ml/hr → 100/1 = 100 drops/min.

How to select a vein for cannulation ?

1. Visible.
2. Palpable.
3. Straight.
4. Distal
5. Not over a joint.
6. Non-dominant hand.
7. Least painful area (medial side of forearm and ante-cubital fossa).

- Decreasing blood sampling in ICU → ↓↓ the need to blood transfusion by 30-50%.
- Blood transfusion is required in ICU in the following:
  - Hb < 7 gm/dl.
  - Hb < 9-10 gm/dl in cardiac, pediatric & head trauma (TBI).
  - Hb drop > 50% in patients with high Hb, e.g, high altitude.
- Arterial extension line → 3-5 ml ... Venous extension line → 7-10 ml.
- Bottles are either:
  - Pressurized: مستطيلة → بتفضى لوحدها من غير ما تتخرم
  - Non-pressurized: مدورة → عالي fluid level بتتطبق ويفضل فيها →

  محتاجة تتخرم أو يتركب فيها IV line with a unidirectional valve يدخل هواء في الازازة عشان يعادل الضغط زي فكرة الابرة اللي بتحطها في فيال البرفلجان .

DRUGS INFUSION

Inotropes

1. Noradrenaline (Levophed)

- ♦ 2 forms → Monotartrate and bitartrate.
- ♦ 3 available preparations (ampoules): 4, 8 & 16 mg.
- ♦ How to prepare for infusion: 16 mg / 50 ml of glucose 5% = 0.3 mg/ml.
- ♦ Infusion rate of 2.5 ml/hr = 0.1 mic/kg/min.
- ♦ Maximum rate → 20 ml/hr = 0.8 mic/kg/min (maximum dose).

بس الكفرة بيقولوا مفيش maximum dose لليفوفيد .
ممكن نعدي الـ maximum levo في عيان سنه صغير في hemorrhagic shock
والدم جاي في السكة ... وفي حالات الـ liver transplantation .
كل الادوية بتتحل علي جلوكوز 5% ماعدا ال Epanutin لأنه بيترسب في الجلوكوز .

- ♦ Indications:
  1. Septic Shock
  2. Cardiogenic Shock
  3. Hypovolemic Shock
  4. Pediatric warm septic Shock
  5. Pediatric cold septic shock (after failure of adrenaline).
  6. Spinal shock without bradycardia

2. Adrenaline

- ♦ 2 available preparations (ampoules): 0.25 mg & 1 mg.
- ♦ How to prepare for infusion: 3 mg / 50 ml of glucose 5%.
- ♦ Dose: 0.05-0.3 mcg/kg/min.
- ♦ Infusion rate: 7 ml/hr = 0.1 mcg/kg/min.
- ♦ In 70 kg patient, maximum dose is 21 ml/hr
- ♦ Indications:
  1. Persistent hypotension despite use of maximum levophed dose.
  2. Spinal shock with bradycardia
  3. Heart block (temporary till pacing)
  4. Pediatric cold septic shock syndrome
  5. Pediatric warm septic shock with BP controlled with levo but low mixed venous saturation (to improve COP & perfusion)
  6. Anaphylactic shock
  7. Status asthmaticus (1 mg/50 ml → Rate 1-2 ml/hr)
- ♦ Complications:
  1. Arrhythmogenic
  2. Lactic acidosis

Dopamine

- ♦ How to prepare for infusion: 200mg / 50 ml of glucose 5%.
- ♦ Dose: 5-20 mcg/kg/min.
- ♦ 1 ml/hr = 1 mcg/kg/min.
- ♦ Indications:
  1. Pediatric septic shock (if other vasopressors are not available).
  2. Cardiogenic shock (in very rare situations ... if tachycardia or arrhythmias occur then stop).

☜ مفيش حاجة اسمها dopamine renal dose

Dobutamine

- ♦ How to prepare for infusion: 250 mg / 50 ml → 1 ml/hr = 1 mcg/kg/min.
- ♦ Dose: 1-20 mcg/kg/min.
- ♦ 1 ml/hr = 1 mcg/kg/min.
- ♦ Indications:
  1. Low mixed venous saturation in Septic shock & Hb >10 gm/dl.
  2. Cardiogenic shock if BP can tolerate.

Other drugs infusion

1. Tridil

- ♦ 2 available preparations: amp 5 mg/ml & vial 1 mg/ml.
- ♦ How to prepare for infusion: 50 الفيال بيتسحب زي ما هو علي سرنجة
- ♦ Dose: 0.5-10 mic/kg/min.
- ♦ Infusion rate of 2 ml/hr = 0.5 mic/kg/min.
  Maximum rate (dose): 40 ml/hr (10 mcg/kg/min.).
- ♦ Indications:
  - AMI, ACS if hemodynamically stable (0.5-2 ml/hr), better than nitroderm patch.
  - Hypertensive crisis (tridil infusion+ dual oral antihypertensive at maximum dose).
  - Stroke: SBP 220 mmHg is accepted → Reduce SBP 20% after 24 hours.
    In case of hemorrhagic stroke → Target SBP is 140-150 mmHg.
  - Spasm of cervix & lower esophageal sphincter: 50 µg IV shot.
- ♦ Tolerance: after 24-48 hrs, effect is under question cause enzyme that metabolizes it into nitric oxide is saturated → nitrate free period for 10-12 hrs then resume.
  If resistant → N-acetyl cysteine IV → increases the enzyme

2. Glypressin

- ♦ Available preparation: Ampoule = 1 mg.
- ♦ Dose in 70 kg patient: Loading 1 mg over 1 hr … Maintenance 1 mg /6-8 hr.
  وينفع يتاخد شوت في hepatorenal syndrome فقط .
- ♦ Indications:
  - Hepatorenal syndrome (infusion has better outcome).
  - Persistent hypotension despite use of maximum levophed & adrenaline doses.
  - Hematemesis.
- ♦ Contraindications:
  - Ischemic heart disease.

  لو عيان عنده angina أخد glypressin يقلب MI

3. Controloc

- ♦ Dose: Loading 80 mg IV shot.
  Maintenance 8 mg/hr (1 amp/ 50 ml → Rate 10 ml/hr).
  If infusion is not available → 40 mg/6-12 hrs shots.
- ♦ Preparation according to type → for stability.
  Losec (omeprazole) → 5 hrs → So: 1 amp/ 50 ml.
  Controloc (pantoprazole) → 10 hrs → So: 2 amp/ml.
- ♦ Indications: Hematemesis.

Drug (inf = infusion)	Dose range	1ml/hr =	Add to 50ml		Notes
Adrenaline (inf)	0.1-2.0 mcg/kg/min	0.1 mcg/kg/min	0.3 mg	x wt	Intravenous, intraosseous. Always via CENTRAL line. In 5%dex or 0.9% N/S
Aminophylline (inf)	1 mg/kg/hr	1 mg/hr		x wt	Load 5mg/kg unless previous aminophylline. FIXED concentration mg/ml. Dose reduced infusion with age. Therapeutic range 10-20mg/l. Toxic tachycardia, jittery, seizures. Dilute in 5% dex
Amiodarone (inf)	5-15 mcg/kg/min	5 mcg/kg/min	15 mg	x wt	Load 25mcg/kg/min for 4 hrs if no previous amiodarone . Baseline thyroid and liver functions. Only dilute in 5% dex. Not <600mcg/ml. Max 1.2g/24hrs. Baseline eye exam /TFT
Dobutamine (inf)	5-20 mcg/kg/min	10 mcg/kg/min	30 mg	x wt	Vasodilatation and tachycardia. Central administration preferred if >5mg/ml.
Dopamine (inf)	5- 20 mcg/kg/min	10 mcg/kg/min	30 mg	x wt	Central administration recommended. For peripheral administration 3x wt in mg (maximum 1.6mg/ml). Dilute in 5% dex or 0.9% N/S.
Esmolol (inf)	25-200 mcg/kg/min			x wt	Loading dose 500mcg/kg over 1 minute. Dilute to 10mg/ml through large bore vein. Dilute in 5% dex or 0.9% N/S. Recommended max concentration 20mg/ml (central administartion). Extravasation risk.
Fentanyl (inf)	1-5 mcg/kg/hr	1 mcg/kg/hr	50 mcg	x wt	Usual dose 1 - 3 mcg/kg/hr. Cumulative effect. Risk of rigid chest in neonates. Discuss with consultant. Dilute in 5% dex or 0.9% N/S.
Furosemide (inf)	0.1- 1 mg/kg/hr	0.2 mg/kg/hr	10 mg	x wt	Dilute in 0.9% N/S only. For concentrated infusions 50 x wt in mg = 1mg/kg/hr= 1 ml/hr. Incompatible with most common infusions
GTN (Glycerine trinitrate) (inf)	1- 5 mcg/kg/min	1 mcg/kg/min	3 mg	x wt	Tachyphylaxis may occur after 24 hrs. Recommended maximum concentration 400mcg/ml. In fluid restricted patients 1mg/ml centrally
Heparin (inf)	10-30 units/kg/hr	20 units/kg/hr	1000 units	x wt	Use APTT to direct therapy.Load 75units/kg. Start infusion at 20 units/kg/hr
Insulin (inf)	0.01- 0.2 u/kg/hr	0.05 u/kg/hr	2.5 units	x wt	Dilute in 0.9% N/S only. Monitor glucose every 30 - 60 minutes at commencement.
Isoprenaline (inf)	0.02- 1 mcg/kg/min	0.2 mcg/kg/min	0.6 mg	x wt	Neonates max 0.2 mcg/kg/min. Maximum for bradycardia 0.5mcg/kg/min. Up to 1mcg/kg/min for heart block. S/E Hypotension. Dilute in 5% dex or 0.9% N/S.
Ketamine (inf)	10-45 mcg/kg/min	10 mcg/kg/min	30 mg	x wt	Anaesthetic, sialogogue. Hallucinations & emergence reactions worse in older children
Labetalol (inf)	0.5-3 mg/kg/hr	1 mg/kg/hr	50 mg	x wt	Neonates start at 500mcg/kg/hr. Hypertensive crisis. Start slowly. Avoid rapid reduction BP. Dilute in 5% dex or 0.9% N/S.
Midazolam (inf)	0.5-20 mcg/kg/min	1 mcg/kg/min	3 mg	x wt	Sedation at lower end of range. Seizure control higher doses. Cardiovascular depression. Dilute in 5% dex or 0.9% N/S.

Drug (inf = infusion)	Dose range	1ml/hr =	Add to 50ml	Notes
Milrinone (inf)	0.3-0.75 mcg/kg/min	0.5 mcg/kg/min	1.5 mg x wt	Phosphodiesterase inhibitor.Vasodilator & inotrope. Dose reduction in renal/ liver dysfunction. Dilute in 5% dex or 0.9% N/S. May be administered centrally undiluted in fluid restrcition.
Morphine (inf)	5-100 mcg/kg/hr	20 mcg/kg/hr	1 mg x wt	Bigger children may need higher doses for a few hours. Dilute in 5% dex or 0.9% N/S.
Noradrenaline (inf)	0.1-1 mcg/kg/min	0.1 mcg/kg/min	0.3 mg x wt	Dilute in 5% dex or 0.9% N/S. Potent vasopressor. Administer centrally
Propofol 1% (inf)	1-4 mg/kg/hr	10 mg/hr	0 mg x wt	1% = 1 kCal/ml in lipid. Use undiluted. Prolonged or high dose infusion associated with propofol syndrome (lactic acidosis and tachycardia)
Prostin (inf)	5- 100 ng/kg/min	10 ng/kg/min	30 mcg x wt	Dinoprostone. NANOGRAMS. Dosing up to 100ng/kg/min for 30-60 mins. Apnoea common in first 24hrs. S/E hypotension, flushing, diarrhoea, low grade temperature. Dilute in 5% dex or 0.9% N/S
Salbutamol (inf)	1-5 mcg/kg/min	0.5 mcg/kg/min	1.5 mg x wt	Dilute in 5% dex or 0.9% N/S. Preferable dilution is 25mg/50ml. Central administration if possible.
Sodium bicarbonate 8.4%(inf)	1-2 mmol/kg/hr	1 mmol/hr	0 mmol x wt	Renal alkalinisation . Very alkaline. High extravasation risk. Central administration preferable, Dilute 1:10 peripherally.
Sodium nitroprusside (inf)	1-5 mcg/kg/min	1 mcg/kg/min	3 mg x wt	Protect from light. Tachyphylaxis after 24 hrs. Toxicity with rising lactate and mixed venous saturations.
Thiopental (inf)	1-8 mg/kg/hr	1 mg/kg/hr	0 mg x wt	Reconstitute with 20ml WFI to give 25mg/ml. Further dilute with 0.9% N/S if required. Status epilepticus. Accumulates in fat. Cardiovascular suppression. Extravasation risk
Vasopressin (inf)	0.0001-0.002 unit/kg/min	0.0005 unit/kg/min	1.5 units x wt	Dosing range: low=0.0001u/kg/min; standard= 0.00025u/kg/min; high=0.0005u/kg/min; maz= 0.002u/kg/min. Dilute in 5% dex or 0.9% N/S.

NUTRITION

Routes

- Oral.
- Enteral: Ryle (nasogastric or nasojejunal), Gastrostomy, Jejunostomy.
- Parenteral (Partial or total).
- Mixed enteral and parenteral (if patient is losing weight with enteral feeding).

- Target: To start enteral feeding as soon as possible to prevent bacterial translocation (fecal capsules), at least trophic 20 ml/hr.
- Oral fluids are good expectorants and improve chest condition.
- Don't rely on intestinal sounds to start enteral feeding.
- Early ambulation is important in paralytic ileus.
- **Surprises:** Enteral feeding is no longer contraindicated in patients on high doses of vasopressors. Once the dose is stabilized, enteral feeding should be started

Oral Feeding

- Sitting 30º - 45º
- Alert
- Patient has access to food الاكل جنب العيان طول الوقت يقدر يطوله بإيده .
- Balance every 4 hours & ensure adequate oral intake, If inadequate → supplement by IV fluids to achieve 2 liters/day.
- Fixed volume per hour.
- The first time should be witnessed especially if stroke patient to exclude bulbar symptoms.
- Clear fluids in case aspiration occurs.
- High protein diet يعني نص فرخة في اليوم زائد فيتامينات e.g. ensure, multivitamins
- 1st day → overlap Ryle feeding & Oral, if adequate → remove Ryle

Ryle Feeding

1. Initiation: Ryle test
2. Contents: 1 ml = 1 Kcal.
   - قاذورات (رايل المستشفي) لا يسمن و لا يغني من جوع -
   - High protein diet.
   - Supplementation (enrich, biogainer).
   - Full enteral nutrition: (expensive 1500 L.E/day)
     - Frusebein في منه 1سم بيدي 1 كالوري و 1 سم بيدي 2 كالوري
     - Peptamin

☜ العيان يفضل يأخد enteral feeding طالما ماسك ضغط حتي لو ماشي علي muscle relaxant أو inotropes .

3. Methods:
   - ♦ Continuous infusion (the best) (there is no such thing as night vacation)
   - ♦ Intermittent boluses → by gravity بسرنجة رايل
     → by force (obsolete)

f food inside ryle tubeWash with 10 ml distilled water after each bolus to avoid fermentation o

4. Length & Route:
   - Length: <u>In adults</u> between 2nd & 3rd marks ... <u>In children</u> has to be measured.
   - Route:
     - Nasal
     - Oral → only in intubated patients (in the following conditions: fracture base, bleeding tendency, difficult insertion) otherwise it increases risk of aspiration.
     - If non-intubated with fracture base (cribriform plate):
       - Unilateral fracture → place Ryle nasal in healthy side very cautiously, not forced & under vision
       - Bilateral fracture → do not insert Ryle

     If irreversible cause or Ryle for > 1 month → consider gastrostomy (either surgical or endoscopic).

5. Insertion:
   - Non-intubated:
     - Place Ryle in fridge
     - Head elevated
     - Stop at oropharynx
     - Wet cotton and ask patient to swallow
     - With first swallow → push Ryle
   - Magil Insertion: Elevate epiglottis with laryngoscope.
   - Esophageal tube: و انت بتقطعها ايدك هتتقطع لف ايدك بشاش

6. Indications: When enteral feeding is okay but oral route is not:
   - ♦ Intubated patient
   - ♦ DCL
   - ♦ Bulbar symptoms
   - ♦ Maxillo-facial trauma

   - Ryle should be inserted for gaseous distension with:
     - Resection anastomosis "suspected leak"
     - Respiratory distress
     - Metabolic acidosis

7. Purpose: Ryle is inserted either for feeding or drainage.
   - Feeding: Open every 6 hours to check residual volume → 300-500 ml → Intolerance → stop & do the following:
     - Give prokinetics
     - Electrolyte correction
     - Gradual increase of volume
     - Consider bypassing stomach to reach jejunum or do jejunostomy
   - Drainage → make sure it drains properly.

     ☜ لو انت حاطط الرايل علشان تفضي بطن العيان و لقيت كيس الرايل فاضي و بطن العيان منفوخة يبقي الرايل مسدود ولازم تعمله flush .

8. Precautions:
   - Patient in semi sitting position all through feeding
   - Initiate with Ryle test
   - Residual volume during course

9. Complications:
   - Of Ryle:
     - ♦ Sinusitis, septal perforation, pharyngitis.
     - ♦ Malposition, endotracheal, kinking.
     - ♦ Tracheo-esophageal fistula.
     - ♦ Aspiration.
   - Of Feeding:
     - ♦ Related to formula: Intolerance, hypo/hyper electrolytes.

10. Termination:
   - Adequate oral intake (after problem resolved).
   - After 40 days → Gastrostomy (endoscopic or surgical).
     If patient deteriorates after gastrostomy consider peritonitis.

Parenteral Nutrition

- Can be total PN or partial PN

1. Route & Daily Requirements:

- Route: Central Line with interlipid in a separate line
- Daily Requirements:

- Fluids: 30 - 45 ml/kg/day بنحسب علي العالي
- In pediatrics → volume is calculated as :
  1st 10 kg → 100 ml/kg/day
  2nd 10 kg → 50 ml/kg/day
  Every 10 kg → 25 ml/kg/day
- Calories: 30-40 Kcal/Kg/day بنحسب علي الواطي + consider stress factor.
- Calories are given as 70% glucose and 30% lipid.
- Protein: 1- 2 gm/kg/day (not counted from caloric intake).
- Potassium: 1 - 2 mEq/kg/day. - Sodium: 1 - 2 mEq/kg/day.
- Magnesium: 300 mg/day (0.3 mmol/kg/day).
- Calcium: 300 mg/day (0.1 mmol/kg/day).
- Trace elements: iron, addamil, glycophos (ampoule/L).
- Vitamins (soluvit + vitalipid), if not available → Give vitamin K, cevarol, becozyme.
- 1 gm glucose = 1 gm protein = 4 Kcal.
- 1 gm lipid = 9 Kcal.
- 500 cc of glucose 5% = 25 gm = 100 Kcal
- 500 cc of glucose 10% = 50 gm = 200 Kcal (in peripheral or central line).
- 500 cc of glucose 25% = 125 gm = 500 Kcal (in central line).
- 500 cc of Intralipid 10% = 450 Kcal (in peripheral or central line).
- 500 cc of intralipid 20% = 900 Kcal (in peripheral or central line).

☜ الـ intralipid مينفعش يتساب متعلق للعيان أكتر من 12 ساعة لأن الـ lipid يعتبر medium for bacteria و ممكن يدخل العيان في sepsis .

- 500 cc of aminostril 10% = 50 gm protein (in central line)
- 500 cc of aminolipan N-hep 8% = 40 gm protein (branched aminoacids → aromatic aminoacids → in central line).
- Nephrostril 6% for renal patients اتلغي من الطب

- Dipeptivan is preferred in burn and neuro patients.
- Panamen G 2.7% & Panamen SG 8% have high chloride content.

- Potassium can be given via peripheral line only if وريد كبير و بوتاسيوم مخفف .
- Drugs that cause thrombophlebitis if given in peripheral vein:
  Cordarone, Aspegic (Acetyl-salicylic acid) & Potassium.

2. Type:

a) Separate components
b) Preformed e.g. smof kapivan or nutrition unit

3. Indications:

♦ Paralytic Ileus: Correct electrolyte disturbance, give prokinetics & early ambulation.
If persistent after 3 days → exclude surgical cause (mechanical obstruction or leakage).
♦ Intolerance to enteral feeding.
♦ GIT leakage.
♦ GIT anastomosis: small intestine (3 days), large intestine (5 days), gastric (7 days).

☞ الكفرة بيقولوا → Immediate oral intake after GI anastomosis improves healing if compared with 3 days delay.

♦ High Inotropic support

يعني maximum levo, maximum adrenaline و مش ماسك ضغط

4. When to start:

- NUTRIC Score

5. Complications of PN:

- Related to Central line.
- Related to formula:
  Hypo and hyper: كل حاجة
  - Volemia
  - Glycemia
  - Proteins
  - Vitamins
  - Trace elements
  - Lipids

➢ Monitoring of TPN:

- Electrolytes → daily.
- Glucose every hour until stabilized then every 6 hours.
- Liver functions & CBC → weekly.
- Kidney functions → every 2 weeks.

☜ لو عايز تبدأ للعيان oral or enteral feeding و خايف يكون عنده leak لازم تعمل:
Abdominal US / 12 hrs + CT with oral contrast + methylene blue

Refeeding syndrome

ده عيان كان malnourished فترة طويلة وجالك الرعاية وانت بدأتله تغذية بالـ full requirements من الأول سواء enteral or parenteral nutrition

- **Clinical picture:**
  - ♦ Severe acidosis, hypotension & organ dysfunction up to cardiac arrest.
  - ♦ Severe electrolyte imbalance (hypokalemia, hypomagnesemia, hypophosphatemia & hypoglycemia)
- **Pathogenesis:** Intracellular shift of phosphate, potassium & magnesium.
- **Management:**
  - ♦ Prevention: Start with 50% of caloric needs and gradually increase intake as tolerated.
  - ♦ Supportive treatment.
  - ♦ Supplement with potassium, magnesium & phosphorus.